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Immediate versus delayed sequential bilateral cataract surgery: an analysis of costs and patient value

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ABSTRACT.

Purpose: **To compare resource utilization of two different strategies for bilateral cataract surgery: immediate sequential cataract surgery (ISCS) versus delayed sequential cataract surgery (DSCS). The purpose was also to analyse the value for the patient of undergoing ISCS versus DSCS.**

Methods: **Differences in routines and resource utilization between ISCS (n = 17) and DSCS (n = 80) were studied in a cohort of cataract surgery patients at our clinic in Karlskrona, Sweden. Costs were extracted from an earlier publication by the same clinic. The value for the patient was studied using the capability index, based on published data on the benefit to the patient of ISCS or DSCS using the Catquest questionnaire.**

Results: **Operating both eyes of a patient was 1.14 times more expensive with DSCS than with ISCS including all surgical costs. The value to the patient of undergoing ISCS depended on the time between first- and second-eye surgery in DSCS and the remaining lifetime after both-eye surgery. A long waiting time for second-eye surgery and a short remaining lifetime decreased the patient value of DSCS compared to ISCS.**

Conclusion: **DSCS is 14% more expensive than ISCS. The value for the patient of ISCS compared to DSCS depends on how long the period will be between first- and second-eye surgery in DSCS and also on the patient's survival time after surgery.**

Key words: bilateral cataract surgery – capability – cataract surgery – costs – resource utilization

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Introduction

Patients with cataract disturbing vision significantly in both eyes usually benefit from having cataract surgery in both eyes. Several studies have shown an additive effect on health-related quality of life (QoL) when second-eye surgery has been performed (Laidlaw et al. 1998; Lundström et al. 2001b). Also, cost–utility analyses have shown the good cost-effectiveness of second-eye cataract surgery (Kobelt et al. 2002; Busbee et al. 2003).

A bilateral cataract extraction can be performed with a varying interval between the two surgeries, so that some patients receive immediate sequential cataract surgery (ISCS) while others have delayed sequential cataract surgery (DSCS) with an interval of weeks or months between the surgeries. ISCS has been described as a favourable surgical approach in selected cases (Smith & Liu 2001; Johansson & Lundh 2003; Sarikkola et al. 2004). The advantage of this kind of surgical strategy is rapid rehabilitation of the patient as well as cost-effectiveness for the hospital and society, according to several investigators (Smith & Liu 2001; Johansson & Lundh 2003; Sarikkola et al. 2004). However, with the exception of an estimate by Johansson & Lundh (2003), studies showing this in hard data are scarce.

We recently performed a study in which patients with bilateral cataract were selected randomly to ISCS or DSCS (Lundström et al. 2006). It was obvious that patients undergoing ISCS had better health-related QoL than patients having DSCS for as long as the second-eye surgery was not performed in the latter group.

Purpose

The purpose of this study was to compare resource utilization of two

different strategies for bilateral cataract surgery (ISCS and DSCS) and to model the value for the patient of undergoing ISCS versus DSCS.

Materials and Methods

All calculations are based on data from the Department of Ophthalmology, Blekinge Hospital, Karlskrona, Sweden. This study is composed of new investigations and previously published material. The new investigations concern time spent on the surgical department in ISCS versus DSCS and waiting time for second-eye surgery in DSCS. Previously published studies that are used in this study concern costs and patients' self-assessed visual function after ISCS and DSCS.

Difference in routines and resource utilization between ISCS and DSCS (new investigation)

Ninety-seven consecutive patients undergoing one- or both-eye cataract surgery between 15 December 2005 and 15 January 2006 at the Department of Ophthalmology in Karlskrona were studied concerning time spent at the surgical department. The time spent from entering the department to leaving on the day of surgery was recorded. The number of visits after surgery was calculated as the existing routine in uncomplicated cases at the department. Furthermore, the average time from first-eye surgery to second-eye surgery was studied in 100 consecutive patients scheduled for second-eye surgery between 3 January and 18 April 2006. Five surgeons performed cataract surgery at the department; the studied patients were distributed evenly between the different surgeons. ISCS constituted 11.5% and 16.5% of all cataract surgeries at the department in 2005 and 2006, respectively.

Costs (previous study)

Data were extracted from a previously published investigation of real costs for personnel, disposables, implants, other surgical material and other costs for cataract surgery care at the same department (Lundström et al. 2000).

Benefits to the patient of undergoing ISCS versus DSCS (new model based on previous study)

How is the value of undergoing cataract surgery measured? It is obvious that the value for the patient lies not in the operation per se but in an improvement in vision (health), the ability to perform activities and the opportunity to choose among activities. We used data extracted from a recently published randomized study (Lundström et al. 2006) to analyse the difference in value for the patient between the two surgical strategies. The method builds on the capability approach to measure outcome of cataract surgery (Roos & Lundström 1998; Lundström et al. 2001a; Roos 2002; Färe et al. 2008). The capability approach allows us to relate changes in medical health status to changes in the ability of individuals to go about their daily activities. Consequently, we can estimate a single index score of capability from a multi-dimensional description of health and daily activities. Capability is a term that reflects the ability to reach activities (and combinations of activities) that a person can potentially achieve given access to healthcare services and socio-demographic and personal features, such as age, sex, income and disability. Health, defined as the physical and mental condition of the body, will of course decrease over time, but capability may not: capability is a relative measure of the 'performance' of an individual given his/her personal features.

In our case, capability refers to the potential improvement in daily activities as a result of cataract surgery. We used the capability approach in our evaluation of outcomes of the two strategies (ISCS and DSCS) to describe the value for the patient. The two strategies may differ in terms of expected changes in capabilities. In the case of ISCS, we expect a direct effect on patients' capabilities. With DSCS, we expect an improvement in capabilities after first-eye surgery, and an additional improvement after second-eye surgery. During the period between first- and second-eye surgery, the patient's capability might be lower compared to ISCS. Unless the time period between the first- and second-eye surgery is very short, and the temporary 'reduction' in capability is negligible, it is essential to measure the reduced patient capability during this period. This temporary 'loss' in capability should be weighed against the consequences of permanent loss of capabilities caused by complications in both eyes as a result of surgery in ISCS.

When comparing the two strategies, it is also important to account for the durability of the operation, i.e. to take a lifetime perspective in evaluating the benefits from cataract surgery. We assume that the durability in intraocular lens (IOL) technology is the same for the two surgeries, but potential improvement in capabilities may differ among the two because of differences in expected survival time for the patient.

The capability index used in this study includes capability data (as outlined in Table 1) as well as summary statistics of the data. The data on activities were collected through interviews with the patients before and after surgery (Lundström et al. 2006). We estimated the capability index for each patient with complete data (Lundström et al. 2006). Details about the calculation of the capability index by means of distance functions and linear programming have been described elsewhere (Lundström et al. 2001a; Roos 2002; Färe et al. 2008).

Results

Differences in resource utilization between ISCS and DSCS, based on measurements of 97 consecutive cataract extractions (17 cases of both-eye surgery and 80 cases of one-eye surgery), are given in Table 2. Patients in the one-eye surgery group (DSCS group) were scheduled for either first-eye or second-eye surgery on the day of measurement. Table 2 shows that ISCS patients had on average four visits to the surgical unit while DSCS patients had on average 7.1 visits (10% had a new preoperative examination before second-eye surgery). Patients' costs for transport and accompanying persons were therefore 1.78 times higher with DSCS compared to with ISCS given equal conditions at each visit.

Time for administration was 15 min in ISCS and 45 min in DSCS. Time for care on the day(s) of surgery was

Table 1. Summary statistics of the variables used in the estimation of capability. Mean values for immediate (ISCS) and delayed (DSCS) sequential cataract surgery.

	ISCS		DSCS	
	Pre	Post	Pre	Post
Eye characteristics*				
Visual acuity (right eye)	0.61	0.94	0.56	0.97
Visual acuity (left eye)	0.61	0.94	0.62	0.96
Binocular contrast vision	1.66	1.85	1.61	1.78
Self-assessed frequency of daily activities that depend on vision*				
Reading	2.24	2.36	2.31	2.43
Walking outdoors	2.51	2.67	2.27	2.61
Watching TV	2.42	2.61	2.30	2.60
Self-assessed difficulties in performing daily activities†				
Difficulty in reading	1.99	1.10	2.08	1.10
Difficulty in walking on uneven ground	1.66	1.14	1.66	1.11
Difficulty in watching TV	1.94	1.09	1.96	1.10

Pre, before surgery; post, after surgery.
* A larger value reflects better acuity, contrast or frequency in activities. † A larger value reflects more problems/difficulties in performing activities. Our data on activities are integer data, thus the means are not values observed in the data.

Table 2. Differences in resource utilization between immediate (ISCS) and delayed (DSCS) sequential cataract surgery in 97 consecutive patients.

Activity/procedure/materials	ISCS	DSCS*
Preoperative examination	1 visit	1.1 visits
Visits for surgery	1 visit	2 visits
Care during day(s) of surgery	114 min	72 + 72 min†
Booking	15 min	30 min
Number of surgeries	2 surgeries	2 surgeries
Disposables	2 units	2 units
Implant (IOL)	2 implants	2 implants
Extra administration	0	15 min
Visits after surgery	2 visits	4 visits

IOL, intraocular lens.
* Patients in the DSCS group were scheduled for either first-eye or second-eye surgery on the day of measurement.
† 72 min per eye.

114 min for ISCS (from entering to leaving the department) and 144 min for DSCS (72 min for each eye from entering to leaving the department).

In 2006, the average period between first-eye and second-eye surgery for patients undergoing DSCS was 5.5 months [standard deviation (SD) 4.6 months]. Eleven patients were excluded because of an unusually long waiting time for personal reasons. The remaining 89 study patients had a mean age of 77.9 years (SD 9 years) and 72% were female.

Difference in time spent on ISCS and DSCS by personnel at the department and the corresponding costs (in SEK/€) according to the cost-effectiveness study in 2000 (Lundström et al. 2000) are outlined in Table 3. DSCS was 1.77 times more expensive than ISCS in terms of personnel costs. The costs of disposables, implants, drugs and machinery (depreciation) are equal for ISCS and DSCS. The total cost including use of instruments, disposables and implants is also shown in Table 3. Including all costs, this makes DSCS 1.14 times more expensive than ISCS.

According to an earlier study (Lundström et al. 2006), there are a number of differences in visual function between patients undergoing ISCS and patients receiving DSCS for as long as second-eye surgery has not yet been performed in the DSCS group. This is shown in Table 4. When the capability improvement was tested using data outlined in Table 1, the result showed similar final improvement (after ISCS and DSCS) – see Table 5 for a summary of results. On average for all patients, the improvement in capability showed an approximately 83% increase in what a person can achieve in terms of daily activities. The results show a greater improvement in capability for ISCS (89%) in comparison to DSCS (79%). For the patient undergoing DSCS, we also estimated the capability index after first eye-surgery. The result showed, on average, an improvement in capability of 31% for this period (significantly less than the final 79% improvement after second-eye surgery). The results indicate that the difficulties experienced when performing daily activities are reduced, but still remain significant.

The average period between first-eye surgery and second-eye surgery in the present study was 5.5 months. The average expected survival time for individuals in Sweden at the same average age as that of our sample of patients is 11.5 years (10.3 years for men and 12.7 years for women). Taking a lifetime perspective, the DSCS regimen with an average period of 5.5 months between first- and second-eye surgery causes a 2.4% [5.5 (79–31) /

Table 3. Number of visits, time spent and personnel costs (in SEK/€) for immediate (ISCS) and delayed (DSCS) sequential cataract surgery.

	ISCS	SEK/€†	DSCS	SEK/€†
Visits for the cataract surgical episode	4 visits	1273/137	7.1 visits	2260/243
Additional costs* for care on day of surgery + booking and administration	83 min	202/22	142 min	345/37
Disposables + IOL		4554/490		4554/490
Other costs (depreciation, rent, GA, inpatient care, educational)		1900/204		1900/204
Total costs		7929/853		9059/974

GA, general anaesthesia; IOL, intraocular lens.
* Costs adjusted for the original calculation on nurse time during the day of surgery.
† Exchange rate: 1€ = 9.3 SEK.

Table 4. Visual function before second-eye surgery in the delayed sequential cataract surgery (DSCS) group compared to the immediate sequential cataract surgery (ISCS) group after both-eye surgery*.

Function	ISCS	DSCS
Visual acuity	1.0	0.8
Total disability score sum (range 7–34)	8.0	11.0
Satisfaction with vision (range 1–4)	1.0	2.0
Cataract symptoms (range 2–8)	3.0	4.0
Car driving (range 2–7)	2.0	2.0

*See Lundström et al. 2006.

Table 5. Change in capability index (%): summary of results.

	After first-eye surgery	After second-eye surgery
All	N/A	+83
ISCS	N/A	+89
DSCS	+31	+79

ISCS, immediate sequential cataract surgery; DSCS, delayed sequential cataract surgery.
Change in capability index is estimated for each patient. The results represent geometric mean.

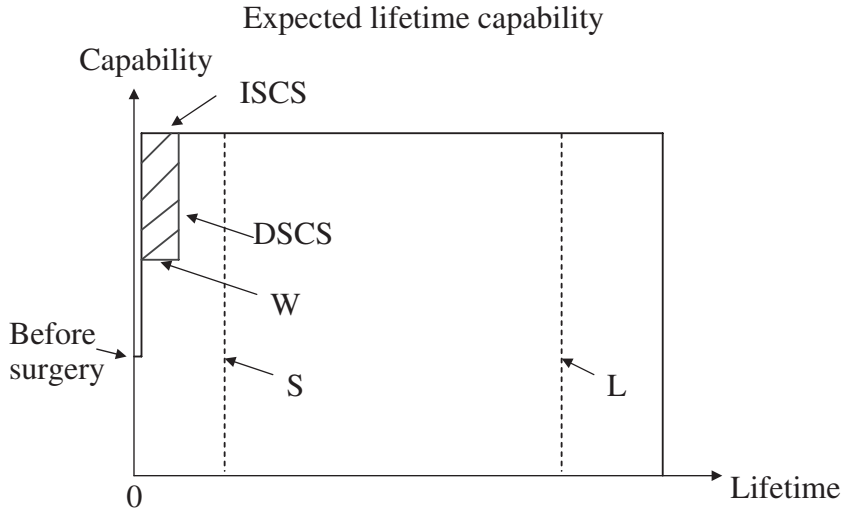

Fig. 1. Schematic representation of the relationship between improved capability after immediate (ISCS) or delayed (DSCS) sequential cataract surgery and the remaining lifetime. The x-axis signifies the remaining lifetime, 11.5 years in our example. S = a shorter lifetime and L = a longer lifetime after bilateral surgery. After ISCS, the capability increases to the upper level (+83% in our study). After DSCS, the capability increases to an intermediate level after first-eye surgery (+31% in our study) and to the upper level after second-eye surgery. The dashed area signifies the capability loss while waiting for second-eye surgery. The waiting time, W (5.5 months in our study), will influence the size of the area; the remaining lifetime (S or L) will influence the loss of capability in a lifetime perspective.

$(11.5 \times 12 \times 79) \times 100]$ 'reduction' in lifetime capability.

Discussion

In this study, we have used data from three different sources: two earlier studies performed at our surgical department (Lundström et al. 2000, 2006) and a new, comparative study of resource utilization in ISCS versus DSCS. Of course, this study approach may introduce some errors based on changes in costs and routines over time. However, the relationship between personnel costs and other costs has presumably not changed during the last 5 years, and the characteristics of our cataract patients appear to have been equal over time.

It is obvious that in our study population, ISCS meant cost-effective surgery and better health-related QoL compared to surgery on one eye at a time. The personnel costs were much lower (−43%) in ISCS compared to DSCS. The difference in total costs was much less (−12%) because of equal costs for both surgical materials. However, 16 eyes of eight patients can be operated by ISCS at the same cost as can 14 eyes of seven patients using DSCS. This result is similar to findings by Arshinoff & Chen (2006), who reported that ISCS yielded 15% greater efficiency in the number of daily operations. The economical gain by doing ISCS compared to DSCS in SEK in our study was also within the limits outlined by Johansson & Lundh (2003). Our data are based on a Swedish population and Swedish healthcare practice. In another healthcare system, the reimbursement for ISCS may be lower than for DSCS and this may influence the choice of surgery (Arshinoff & Chen 2006).

The capability index in our model was based on health measurements and self-assessed visual function and ability of perform daily activities, as outlined in Table 1. The self-assessed parameters were collected using the Catquest questionnaire (Lundström et al. 1997, 1998, 2006). Using questions about different daily activities or using different scoring may have resulted in different findings. However, changing the scale in our model did not change the result significantly. The expected temporary loss in capability in DSCS is, of course, very much related to expected survival time for the patient. If the expected survival time is only a few years, the reduction in lifetime capability will increase (Fig. 1). If, for example, the expected survival time is 3 years, DSCS may cause a 16% reduction in lifetime capability compared to ISCS.

Traditionally, the objection against ISCS is the possibility of irreversible sight loss in both eyes because of complications, which could be avoided in at least one eye if only one eye is operated on at a time. This may be true in extremely rare cases. There is only one report in the literature of bilateral endophthalmitis after simultaneous bilateral cataract surgery (Özdek et al. 2005). In that patient, the final visual acuity in both eyes became reasonably good. Besides, bilateral endophthalmitis has also been reported to occur after DSCS (Nicoli & Wainsztein 2001). Bilateral corneal oedema, cystoid macular oedema and retinal detachment are other possible complications that make careful patient selection crucial before suggesting ISCS. However, these complications may also occur after DSCS if both eyes are operated with a short interval, i.e. before the complication in the first eye is recog-

nized. The possibility of permanent sight loss in both eyes after ISCS should be balanced against the reduction in capability resulting from DSCS. However, permanent sight loss in both eyes after ISCS will not have a significant impact on expected average lifetime capability because it is so rare. If it is possible to identify patient groups with increased risk of serious complications from surgery, the impact on expected lifetime capability may be significant and is a factor that should be accounted for in the evaluation of the surgical strategy.

A cataract extraction in both eyes on the same day (ISCS) may result in an unexpected difference in refraction between the eyes. Johansson (2004) studied 165 consecutive cases of same-day bilateral cataract surgery and found that in 71% the final refraction was within ±1 D. No patient returned with complaints caused by the postoperative refraction (Johansson 2004). One advantage with DSCS is the possibility to make corrections for refractive surprises after first-eye surgery. However, in a recent publication the authors point out that a refractive surprise after first-eye surgery cannot be used to make corrections in the second-eye surgery because a patient's two eyes behave differently (Jabbour et al. 2006).

In modern ophthalmic surgery, there are many examples of surgical strategies that imply increased risks for our patients, including bilateral refractive surgery in healthy but ametropic eyes (Albelda-Vallacs et al. 2007), scleral-sutured posterior chamber IOLs in aphakic eyes with good vision (Wagoner et al. 2003) and clear corneal incisions in cataract surgery resulting in a slightly increased risk of endophthalmitis (Lundström et al. 2007). The risks are taken because the benefit of performing the surgical procedure is judged to be greater than the risks. Our study confirms that ISCS means reduced costs compared to DSCS, and this enables a clinic to perform approximately 12% more operations within the same budget. We have also calculated the increased capability for the patient after ISCS. The value to the patient of having ISCS rather than DSCS in terms of lifetime capability will depend on the alternative treatment (time period between first- and second-eye surgeries in DSCS) and the remaining lifetime for the patient. A shorter remaining lifetime and a long interval between surgeries in the case of DSCS will increase the value of choosing ISCS for the patient. This is demonstrated in Fig. 1. Note that capability is a relative measure of how well the person is doing in terms of activities, given access to healthcare services, socio-demographic and personal features. For this reason, capability is illustrated with a horizontal line in Figs 1 and 2.

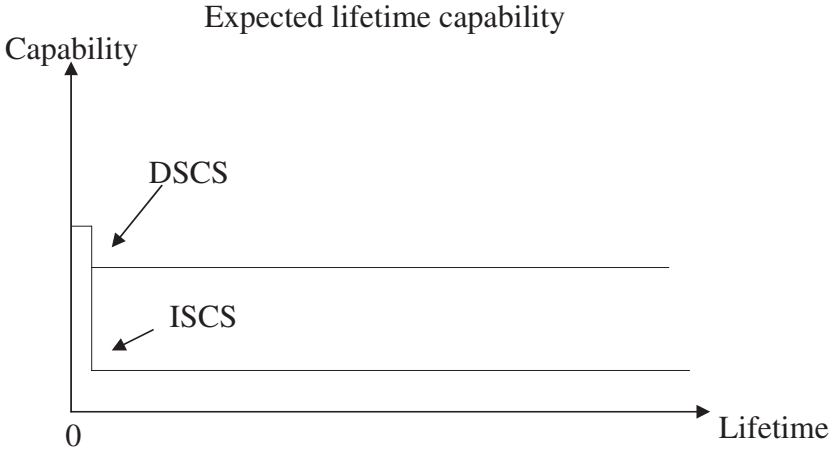

Fig. 2. Two cases illustrating the consequences for the patient of serious complications resulting from surgery. Case 1: delayed sequential cataract surgery (DSCS). Loss of vision caused by complications resulting from surgery on the worst eye. Surgery on the second eye is cancelled. Case 2: immediate sequential cataract surgery (ISCS). Loss of vision caused by complications resulting from surgery on both eyes.

If complications occur after first-eye surgery, there will always be the choice for the patient to wait and see before undergoing second-eye surgery. This option is, of course, not available with ISCS. The ability to make a choice may be very important for some patients. For others, the chronic progressive nature of cataract and the urgency of performing second-eye surgery to prevent blindness mean that the possibility of choosing is less important. The consequences for the patient of serious complications occurring from surgery are outlined schematically in Fig. 2.

Careful patient selection is important in planning ISCS (Ainsworth 2006), as is strict aseptic separation of the two procedures (Arshinoff 2006). This has been highlighted in a recent publication (Kashkouli et al. 2007). Perhaps it is time for a more positive attitude towards ISCS in patients with cataract in both eyes and no known risk factors. The advantages of ISCS have been proven, while the disadvantages seem to be less significant than previously believed.

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