Why Do Phacoemulsification? Manual Small-Incision Cataract Surgery Is Almost as Effective, but Less Expensive

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Purpose: To compare the cost of phacoemulsification with foldable lenses with that of manual small-incision cataract surgery (SICS) in a hospital setting.

Design: Average cost comparision between 2 surgical techniques.

Participants: Four hundred patients and 4 surgeons.

Methods: A single masked randomized controlled clinical trial was conducted previously to compare safety and efficacy of the 2 techniques for rehabilitation of the cataract patient. The fixed-facility and recurrent (consumables) cost for phacoemulsification and SICS were calculated based on information collected at different sources using standard norms. Average cost per procedure was calculated by dividing the total cost by the number of procedures performed.

Main Outcome Measures: Average fixed-facility cost and average consumable cost for both the techniques.

Results: The average cost of a phacoemulsification surgery for the hospital was Indian rupees (Rs) 1978.89 ($42.10), and the average cost for a SICS surgery was Rs 720.99 ($15.34), of which Rs 500.99 ($10.65) was the fixed-facility cost common to both. Phacoemulsification cost was more because of the foldable lens used.

Conclusions: Phacoemulsification needs additional cost for the machine (depreciation), replenishment of parts, and annual maintenance contract. Manual SICS is far more economical than phacoemulsification. Its visual result is comparable with that of phacoemulsification and is as safe. *Ophthalmology 2007;114:965–968 © 2007 by the American Academy of Ophthalmology.*

A large backlog of cataract blindness exists in the developing world, and cataract is still the most common cause of avoidable blindness.[1] An estimated 4 million people experience blinding cataract every year in India.[2] Nearly 4 million cataract surgeries are performed in India annually, but only a small proportion of these are performed on patients who are blind because of cataract.[3]

In terms of disability-adjusted life years, cataract extraction is one of the most cost-effective of all surgical interventions[4,5] in terms of quality of life restored. Cataract surgery accounts for most of the workload of ophthalmic units in India. Researchers estimate that cataract annually causes a loss of US$4.4 billion to India in terms of loss of workdays for patients and their caretakers, the cumulative loss for the entire lifespan of the patient being US$22.2 billion.[6] However, the cost of tackling cataract blindness is US$0.15 billion.[6] A technique of cataract surgery that is safe and effective for visual rehabilitation yet economical is needed.

Phacoemulsification is the most popular technique of choice for cataract surgery in the Western world. It accounts for a large share of the health care budget in the United States.[7] A randomized trial in the United Kingdom[8] found phacoemulsification to be more effective and economical than conventional extracapsular cataract extraction surgery. In phacoemulsification, an ultrasound probe enters through a 3-mm or 2.8-mm tunnel incision and emulsifies the cataract nucleus. The surrounding cortex is removed using an irrigation aspiration cannula and a suction pump. The conventional extracapsular cataract extraction uses a 12-mm incision at the superior limbus that is closed with sutures. The phacoemulsification wound usually does not need sutures.

Manual small-incision cataract surgery (SICS) involves removing the cataract nucleus through a 6-mm scleral tunnel and aspirating the remaining cortex. Usually, the tunnel is self-sealing and does not need sutures. A study done in India found SICS to be more effective than extracapsular cataract extraction[9] and more economical.[10] The SICS is carried out without the phacoemulsification machine. All 3 techniques need a posterior chamber intraocular lens for better visual rehabilitation. This study compares the average cost of phacoemulsification and SICS in a hospital setting.

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Table 1. Calculation of Fixed-Facility Cost

Fixed-Facility Cost	Indian Rupees
Hospital building 8 533 693 (life 30 years)	284 465.43
Hospital furniture, fixtures, movable assets 425 400 (life 7 years)	607 714.29
Medical equipment 17 174 183.00 (life 5 years)	3 434 836.60
Depreciation	17 700.00
Hospital maintenance	3 303 287.00
Office maintenance	415 279.00
Medical staff salary	3 180 000.00
Paramedical staff salary	1 001 191.00
Administrative staff salary	612 000.00
Total	8 511 757.00/17 000 (500.69, $10.65)

Materials and Methods

A single masked randomized controlled trial was used to compare the safety and efficacy of manual SICS with phacoemulsification.[11] In both techniques, a posterior chamber intraocular lens was implanted. The details of ethical considerations, sample size calculations, surgical techniques, randomization, masking preoperative and postoperative visual acuity results, and complications are discussed elsewhere.[11] In the current article, we focus on the cost of these procedures. The average cost was calculated by standard methods[12]; the building, equipment, and instruments cost was calculated as depreciation and was added to the human resource cost, hospital mantainance cost, and consumable cost. Average cost per procedure was calculated by the total cost divided by the number of procedures performed.[13] Both techniques had a common expenditure for fixed facility: hospital building; equipment; hospital and office maintenance; and medical, paramedic, and administrative personnel.

The fixed-facility cost was calculated from the annual audit report of the hospital. The preoperative and postoperative protocol were exactly the same for both the techniques. The total time that a surgeon took for surgery was recorded using a stopwatch in minutes and seconds. The time was calculated from the time the patient was draped for surgery to the time the drapes were taken off. The average personnel cost for each procedure was calculated using the time required to perform it.

In a high-quality high-volume surgical setting, each trained experienced ophthalmologist performs numerous cataract surgeries in quick succession.[14] This allows optimum use of human resources and consumables, because they are used for more than 1 surgery, and saves time and money.[15] Up to a dozen or more surgeries may be performed on a single operative microscope with trolley.

Each operation trolley (with the scrub nurse) was allocated a fixed number of consumables. Any more needed or those not used during the surgery list were noted along with the number of surgeries performed. Some items were used for multiple surgeries (ointment, dilating eye drops, viscoelastic, and blades and sutures after sterilization). The consumable cost was calculated by finding out the number of surgeries for which 1 unit of the material was used, x, and then dividing the cost of that unit by the number of surgeries used for x to calculate the average cost of that material for 1 surgery.

Results

The fixed-facility cost included hospital maintenance, office maintenance, medical, paramedic and administrative staff salary, and the depreciation on the hospital building, furniture, equipment, and other instruments. Hospital maintenance included expenditure on electricity, water, cleaning, vehicle fuel, generator fuel, laboratory, garden, painting, canteen, uniforms, and so forth. The office maintainence included cost of printing stationery, postage, phocopying, telephone, and so forth. The depreciation was calculated on amount spent for hospital building, vehicle, furniture, equipment (including phacoemulsification machine), and instrumentations (Table 1). The total cost for the fixed facility was divided by 17 000, the total number of cataract surgeries perfomed in that year. The average cost per procedure for the fixed facility was Indian rupees (Rs) 500.99 ($10.65), as shown in Table 1.

The average time for SICS was 8 minutes and 35 seconds, whereas for phacoemulsification it was 15 minutes and 30 seconds. The cost for the consumables was Rs 1206.80 (US$25.68) for phacoemulsification and Rs 220.30 (US$4.69) for SICS, as shown in Table 2. The Indian-made hydrophilic acrylic foldable lens cost

Table 2. Average Consumable Cost Calculation in Indian Rupees

Item	Cost	Used for x Surgeries		Cost per Surgery	
		Phacoemulsification	*Manual Small-Incision Cataract Surgery*	*Phacoemulsification*	*Manual Small-Incision Cataract Surgery*
Intraocular lens (hydrophilic acrylic)	1100.00	1	0	1100.00	0
Intraocular lens (PMMA)	120.00	0	1	0	120.00
Keratome blades	160.00	7	8	22.85	20.00
Viscoelastic	30.00	2	3	15.00	10.00
10-0 suture	230.00	26	18	8.85	12.77
Ringer's lactate	13.75	2	3	6.88	4.42
All other consumable				53.07	53.07
Total				1206.8 ($25.68)	220.3 ($4.68)

PMMA = polymethyl methacrylate.

Table 3. Average Cost of Surgery in Indian Rupees

	Phacoemulsification	Manual Small-Incision Cataract Surgery
Fixed-facility cost	755.20	755.20
Consumable cost	1206.80	220.30
Additional phacoemulsification cost	271.40	000.00
Total	2233.40	975.50
	$47.52	$20.75

Rs 1100.00 (US$23.40), whereas the Indian-made polymethyl methacrylate (PMMA) rigid lens cost Rs 120.00 ($2.55).

The cost of the phacoemulsification machine was added as depriciation of the phacoemulsification cost (Rs 280 000 annually), its annual maintenance contract (Rs 70 000), and the replenishment of tips and other accessories (Rs 29 890). This was used for 1400 phacoemulsification surgeries. The additional cost per procedure for the use of phacoemulsification machine was Rs 271.40 (US$5.77). The average cost per procedure for phacoemulsification was Rs 1978.89 (US$42.10), and for SICS it was Rs 720.99 (US$15.34; Table 3).

If the consumables were to be used only once, then the cost of consumables for both the procedures would be higher: Rs 2490.00 (US$53.00) for phacoemulsification and Rs 1330.00 (US$28.30) for SICS. The final average cost would be Rs 3262.09 (US$69.40) for phacoemulsification and Rs 1830.69 (US$38.95) for SICS.

Discussion

The randomized trial in Pune, India, showed SICS to be almost as effective as phacoemulsification and equally safe.[11] The difference in uncorrected visual acuity at 6 weeks was small (81.1% of phacoemulsification ≥6/18 without spectacle correction as compared with 71.1% in SICS). But the cost of SICS is substantially lower (US$15.74 vs. US$42.10 for phacoemulsification). Phacoemulsification needed more costly consumables (the foldable intraocular lens) and the cost for purchase and maintenance of the machine. Reuse of consumables also accounted for the lower cost in SICS. This was possible in a high-quality high-volume setting only. If the consumables were to be used only once, then the cost of consumables for both the procedures would be higher: Rs 2490.00 (US$53.00) for phacoemulsification and Rs 1330.00 (US$28.30) for SICS, and the final average cost would be Rs 3262.09 (US$69.40) for phacoemulsification and Rs 1830.69 (US$38.95) for SICS.

The major difference in the cost is the result of the price difference of the intraocular lens used. The Indian-made hydrophilic acrylic lens costs Rs 1100.00 (US$23.40). A sharp-edge silicone lens costs approximately Rs 3500.00 (US$74.50), whereas the hydrophobic acrylic foldable lens (AcrySof, Alcon Inc., Fort Worth, TX) costs more than Rs 4800.00 (US$102.10). An Indian-made square-edge PMMA lens costs approximately Rs 400.00 (US$8.50). All these lenses reduce the incidence of posterior capsular opacification, but add substantially to the cost of the procedure.

The difference in astigmatism between the 2 techniques is because of the size of the incision. If a PMMA lens is used in phacoemulsification, then the cost is closer to that of SICS, but the difference in astigmatism also disappears. The average cylindrical correction for phacoemulsification was 0.9 for the Pune study, which was more than that for a trial in the United States.[16] The U.S. study considered the vector difference between the preoperative and postoperative astigmatism, whereas the Pune study considered the final cylindrical correction of the patient. The former used stainless steel keratomes, whereas the latter used diamond knives. The use of a diamond knife would have increased the cost of the phacoemulsification procedure further.

So even if the intraocular lens cost is the main price differential between phacoemulsification with a foldable lens and manual SICS, the lesser size of incision is the rationale for doing phacoemulsification[16] and the reason for its better uncorrected visual acuity results. If a PMMA lens is used in phacoemulsification, the cost is closer to that of manual SICS, but so is the degree of astigmatism.

The cost for SICS at US$15.34 was similar to the cost in the same institute in a similar study in 2003.[10] The cost of phacoemulsification is much less than the cost calculated during a randomized trial in the United Kingdom in 2001,[8] but that was in a developed country setting, whereas this study was carried out in a third world setting. The cost findings compare with findings of Singh et al[17] in an Indian setting.

A single case of phacoemulsification (1/200) in the randomized trial[11] had dropped nucleus, and the patient was managed by referral to a vitreoretinal clinic and subsequent intervention. The patient had a final visual acuity of 6/24. The cost of managing this complication was Rs 14 445.00 (US$307.30). This worked out to be Rs 72.20 (US$1.50) per surgery on average. The incidence of retained cortex and iritis was the same for both techniques. Because the follow-up was only 6 weeks, there was no posterior capsular opacification, which would need laser capsulotomy.

The small difference in uncorrected visual acuity may make the use of spectacle correction optional for phacoemulsification, because many phacoemulsification patients would not need spectacles and others would have smaller cylindrical errors. The average time for SICS was 8 minutes and 35 seconds, whereas that for phacoemulsification was 15 minutes and 30 seconds. So in a busy facility, a surgeon would be capable of handling higher volumes with SICS. Thus, the personnel costs for phacoemulsification would be higher. Phacoemulsification needs longer training and is performed by more experienced (and better paid) surgeons in the hospital. Also, surgeons find it easier to switch from conventional extracapsular surgery to SICS rather than phacoemulsification. The learning curve for phacoemulsification also is steeper. The personnel cost for phacoemulsification is likely to be much higher than that for SICS because of increased surgeon time and higher salaries and would increase the cost difference in both techniques. The cost and the availibility of the phacoemulsification machine, its maintenance, replenishment of accessories, and need for trained phacoemulsification surgeons make SICS the technique of choice wherever any one of these factors is not available.

The costs in both arms may be slightly underestimated as the federal government (of India) and the state government (of Maharashtra) give substantial tax benefits for the purchase and import of equipment and consumables to hospitals working for blindness prevention and control. But any difference would be same for both the techniques.

In our practice setting, SICS was more economical than phacoemulsification. It was as safe and nearly as effective as the latter. It is recommended as an alternative to phacoemulsification for the rehabilation of the cataract patients in developing countries where requisite equipment and trained personnal for phacoemulsification may not be available. It would be of great use in large national or community blindness prevention and control programs that tackle cataract blindness and visual impairment and make best use of available resources.

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