SCIENTIFIC REPORT

Is manual small incision cataract surgery affordable in the developing countries? A cost comparison with extracapsular cataract extraction

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Br J Ophthalmol 2003;**87**:843–846

Aim: To compare the cost of manual small incision cataract surgery (MSICS) with conventional extracapsular cataract surgery (ECCE) in community eye care settings.
Method: A single masked randomised trial was used to compare the safety, efficacy, time, and patient satisfaction of surgery by both the techniques. The fixed facility and recurrent cost for the two procedures was calculated based on information collected from different sources. Average cost per procedure was calculated by dividing the total cost by the number of procedures performed.
Result: The average cost of an ECCE procedure for the hospital was Rs 727.76 (US$15.82) and the average cost of a MSICS procedure was Rs 721.40 ($15.68), of which Rs. 521.51 ($11.34) was the fixed facility cost common to both.
Conclusion: Both ECCE and MSICS are economical in community eye care settings, but MSICS is economical and gives better uncorrected visual acuity in a greater proportion of patients.

A huge backlog of cataract blindness exists in the developing world.[1] It is estimated that 3.8 million people develop blinding cataract every year in India,[2] as against 2.7 million cataract surgeries done every year.[3] Any type of cataract surgery, which hopes to tackle this backlog, has to be affordable to the service providers and ultimately the service recipients. 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 the majority of the workload of ophthalmic units worldwide. Researchers estimate that cataract annually causes a loss of US$4.4 billion to India, the cumulative loss for the entire lifespan being US$22.2 billion.[6] On the other hand the cost of tackling cataract blindness is US$0.15 billion.[6]

Phacoemulsification is considered the standard of care for cataract surgery in the developed world.[7] Cost, in terms of equipment and training, has limited its use in the developing world. High quality, high volume cataract surgery has been popularised in community eye care centres to effectively manage the large backlog of cataract blindness.[8] This is mostly extracapsular cataract extraction with intraocular lens implantation. Manual small incision surgery through a scleral tunnel that does not need to be sutured may be a more appropriate technology for such settings.[9 10] It needs similar equipment and facilities like the conventional ECCE that are readily available in most centres.

This study compares the average cost of MSICS and ECCE-PCIOL in a hospital based community eye care setting.

METHODS

A single masked randomised control clinical trial was used to compare extracapsular cataract extraction (ECCE) and manual small incision cataract surgery (MSICS) for safety, effectiveness, time, and patient satisfaction. In both techniques a posterior chamber intraocular lens (PCIOL) was implanted. The details of ethical consideration, sample size calculation, surgical technique, randomisation, masking, preoperative and postoperative visual acuity results, and complications are discussed elsewhere.[9] The average cost was calculated by standard method.[11 12] Average cost per procedure was calculated by dividing the total cost by the number of procedures performed.

Both the procedures had a common expenditure for the fixed facility—hospital building, equipment, hospital and office maintenance, and personnel—medical, paramedic, administrative. The cost for the fixed facility was calculated from the annual audit report of the hospital. The ward and admission cost were included in the hospital maintenance and personnel heads. Camp patients were transported at the hospital's cost.

The preoperative protocol and the postoperative follow up were exactly the same for both the techniques. A trained, experienced surgeon performed numerous surgeries in succession to allow for optimum use of consumables. This saved time and money. High quality high volume surgery is a method in which an experienced surgeon performs a dozen or more surgeries at a stretch, while maintaining high quality.[8] The average personnel cost for a procedure was calculated using the time required to perform it. A stopwatch was used to measure the surgery time in minutes and seconds. The watch was started on putting the speculum at the beginning of surgery and stopped when the speculum was removed when the surgery was over.

Each operation trolley was allocated a fixed number of consumables required for surgery. Any more needed or those not used at the end of the operating list were noted along with the number of surgeries done. Few items were used for multiple surgeries (ointment, dilating eye drops, blades, and sutures after sterilisation). The consumable cost was calculated by first finding out the number of surgeries done (x) in one unit of the material 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 one surgery. A surgeon did only one kind of surgery (ECCE or MSICS) at each operating session. This unorthodox method was used to help calculate the cost of consumables used for a particular kind of surgery.

RESULTS

The fixed facility cost included hospital maintenance, office maintenance, medical, paramedic, and administrative staff salary, and depreciation on the hospital building, furniture, equipment, and instrumentation.

Hospital maintenance includes expenditure on electricity, water, cleaning, vehicle fuel, generator fuel, garden, painting, canteen, etc. Office maintenance includes expenditure on stationery, postage, telephone, fax, computers, banking, etc. The

Table 1 Surgeon time for both techniques

Surgeon	ECCE	Mean	Range	MSICS	Mean	Range
A	71	11 m 27 s	7 m 5 s–20 m 5 s	53	12 m 7 s	8 m–18 m
B	50	11 m	7 m 50 s–20 m	60	11 m 35 s	7 m 58 s–26 m 39 s
C	61	11 m 14 s	8 m 30 s–15 m	52	11 m 33 s	7 m 50 s–20 m 50 s
D	29	14 m 3 s	10 m 25 s–20 m 22 s	53	13 m 18 s	8 m 59 s–27 m 28 s
E	40	10 m 39 s	8 m 28 s–15 m 2 s	68	9 m 55 s	6 m19 s–16 m 38 s
F	57	12 m 43 s	9 m–17 m 50 s	52	12 m 41 s	7 m 2 s–25 m 26 s
G	37	16 m 50 s	8 m–25 m 40 s	6	17 m 35 s	11 m 35 s–23 m 30 s
H	38	13 m 10 s	7 m–23 m 30 s	14	14 m 10 s	9 m 45 s–20 m
For all	383	12 m 21 s	7 m–25 m 40 s	358	11 m 57 s	6 m 19 s–27 m 28 s

m = minutes; s = seconds.

Table 2 Calculation of the average cost for the fixed facility

	Cost in Indian rupees*
Hospital maintenance	657 699.00
Office maintenance	336 539.00
Medical staff salary	1 255 000.00
Paramedical staff salary	280 470.00
Administrative staff salary	332 080.00
Total running cost (A)	2 861 798.00
Hospital building construction	8 132 693.00
Medical and other equipment	10 359 183.00
Depreciation per year for building with life = 15 years (B)	542 179.50
Depreciation per year for equipment with life = 5 years (C)	2 071 836.60
Depreciation (B+C)	2 614 016.10
Fixed facility cost (A+B+C) per year 10 500 surgeries done in a year	5 475 814.10
Average fixed facility cost per surgery ($11.34)	**521.51**

*US$1 = Rs 46.

depreciation was calculated on the amount spent for the hospital building, vehicles, furniture, equipment and instrumentation.

The average time taken for ECCE was 12 minutes 21 seconds and for MSICS was 11 minutes 57 seconds. The maximum time was 25 minutes 40 seconds, and 27 minutes 28 seconds, minimum time was 7 minutes and 6 minutes 19 seconds and the standard deviation was 3 minutes 14 seconds and 2 minutes 52 seconds, respectively. Those 21 patients whose surgical technique had to be converted from MSICS to ECCE on average took a longer time (mean 13 minutes 53 seconds; range 9 minutes 35 seconds to 25 minutes 26 seconds).

Using the t test, the p value is 0.0767 and t value is 1.772. Bartlett's test for homogeneity of variance shows that they are homogenous with 95% confidence. There is no statistical or clinically significant difference between both the groups for surgical time. The average surgery times for the eight study surgeons are shown in Table 1.

Using the t test and Bartlett's test for homogeneity of variance, the variance in the sample differs. There is a significant difference in the operating time of different surgeons recruited in the study. However, each of them is performing the two procedures in comparable time.

Both the surgeries were done in comparable time, using similar personnel time and thus the personnel cost was same for both. The average fixed facility cost was common to both the techniques; it was calculated to be Rs 521.51 ($11.34), as shown in Table 2.

The two types of procedures differed in the use of consumables. The average consumable cost calculation details are in Table 3. The average consumable cost for ECCE was Rs 206.24 ($4.48) and for MSICS was Rs 199.89 ($4.34).

Table 4 shows the average cost of surgery by both the techniques. It was Rs 727.76 ($15.82) for ECCE and Rs 721.40 ($15.68) for MSICS.

DISCUSSION

High quality high volume surgery is the preferred method of delivery to tackle the large backlog of cataract blindness.[8] High volume and bulk purchase of locally available consumables helped reduce cost. The cost of the fixed facility per surgery is reduced by the high turnover.[13] This was $11 because of the high volume of work done, more than 10 000 surgeries per year. High quality and low cost in turn helps generate the high volume setting up a positive feedback cycle[14]:

Low cost + high quality = high volume

MSICS is as safe an ECCE, but gives better visual acuity without spectacles[9] and can be done in similar time. It can thus be done in a high volume high quality setting.

MSICS does not need extra equipment compared to ECCE. The fixed facility (in this case a community eye care hospital) is common to both.

The average time (range) taken for each surgery in both the groups was 12 minutes 21 seconds (7 minutes to 25 minutes 40 seconds) for ECCE and 11 minutes 57 seconds (6 minutes

Table 3 Average consumable cost calculation

			Used for 'x' surgeries		Cost per surgery (in Indian rupees)	
	Item	Cost	ECCE	MSICS	ECCE	MSICS
1	Intraocular lens	120.00	1	1	120.00	120.00
2	Viscoelastic	36.36	6.55	5	5.55	7.27
3	8-0 Suture	117.00	4.68	18.57	25.00	6.30
4	Keratome blades	160.00	0	14.2	0	11.27
5	Blade (packet) for incision	3.52	5.5	0	0.64	0
6	All other items				55.05	55.05
				Total	**206.24**	**199.89**

Table 4 Average cost per surgery by both techniques

	ECCE	MSICS
Consumable cost per surgery	Rs 206.24 ($4.48)	Rs 199.89 ($4.34)
Fixed facility cost per surgery	Rs 521.51 ($11.34)	Rs 521.51 ($11.34)
Average cost of surgery in rupees	Rs 727.76	Rs 721.40
Average cost of surgery in US$ (US$1=Rs 46)	$15.82	$15.68

19 seconds to 27 minutes 28 seconds) for MSICS. There was also statistically significant difference between surgeons for the surgical time; but each performed both techniques in comparable time. Thus the personnel cost was similar for both. The surgeons of MILS[15] had an average time between 12.3 minutes and 18.5 minutes (average of 15.9 minutes for all four surgeons). Surgery in the ACIOLs in Lahan[16] took 6.0 minutes on average (3.0–17.2 minutes).

The majority of the consumables used are also common. The two techniques differed only in the use of incision blades (MSICS needed keratomes), sutures (rarely needed in MSICS) and viscoelastic (used more in MSICS). All other consumables—intraocular lens, eye drops, ointment, irrigating fluids—were used similarly.

In a high volume surgical setting, blades and sutures are reused after formalin chamber sterilisation or autoclaving. The viscoelastic is used over many surgeries after changing the canula. With stricter medicolegal norms, consumer protection and fear of viral and prion diseases, these norms need to be reassessed. But the cost of consumables in both types of surgery is bound to remain similar. Bulk purchase of locally produced consumables was responsible for low cost

This may account for the relatively low cost estimated compared to similar studies in Nepal[17] (provider cost of $16 in Nepal) and Mysore, India[18] (provider cost for NGO was $30). Only the provider cost (accrued by the hospital and partners) was calculated, not the consumer costs. The money spent by the outpatients in coming to the hospital and spectacle cost was not calculated, unlike the costing done for phaco in the United Kingdom.[5] Better uncorrected visual acuity in MSICS would mean less expense on spectacles.

MSICS was marginally more economical than ECCE. There may be a study effect as MSICS patients may need fewer postoperative eye drops, follow up visits, and spectacles, and the cost may work out to be more economical.

Internal validity

The 24 ophthalmic assistants, 14 ophthalmologists, two anaesthesiologists, two social workers, five scrub nurses, four theatre assistants, three OPD nurses, and three administrative staff, who contributed to the study, all formed part of the regular hospital team. All of them were extensively briefed and a pilot run for the study. A multimember, multidisciplinary, ethics committee monitored the study.

External validity

Such efficient use of consumables and cost containment is valid only in high quality high volume setting. The high volume accounting for low cost of fixed facility and consumables may not be available everywhere, but the relatively low cost incurred shows that promotion of more such centres in the Third World may be a cost effective way to tackle the backlog of cataract blindness.

The research protocol was designed to reflect the actual working of the community eye care centre/hospital as close as possible. Preoperative, postoperative, and follow up procedures were kept the same. Surgeons of varying experience were recruited, provided they fulfilled the basic criteria.

The randomisation sequence was designed to reflect the high quality, high volume operation theatre setting. Thus, the cost of consumables and time for surgery calculated would mirror the use in regular circumstances.

Limitations of the study

Only the provider cost (what the hospital spent) was calculated, not the consumer cost (what the patient had to pay for transportation, loss of workdays, etc). There may be a study effect as MSICS patients may need fewer postoperative eye drops and follow up visits, and may work out to be more economical. The tax concessions given by the State Government (of Maharashtra) and Union Government (of India) for community based hospitals helped lower the cost of equipment. Money spent on surgeon and paramedical staff training was not taken into account. The salary the hospital paid was considered the annual premium for the training. But any difference would have been same in both the arms.

ACKNOWLEDGEMENTS

This study was funded by a grant from HV Desai Eye Hospital, Pune, and the Department for International Development, UK. Mr Richard Wormald and Dr Daksha Patel helped in planning the study. Dr Angela Reidy and Dr BR Shammanna gave valuable inputs in cost analysis and write up. We are grateful to Niranjan Pandya, Col Vinayak Andurkar, Mahesh Kamble, and Vikas Bhoj of the Finance Department of the hospital for making the data available. Ravilla Thulasiraj and Allen Foster gave advice for high quality high volume costing.

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Accepted for publication 20 November 2002

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ECHO

Autosomal dominant Weill-Marchesani and Marfan syndromes are two sides of the same coin

Please visit the British Journal of Ophthalmology website [www.bjophthalmol.com] for link to this full article.

A genetic study has suggested that autosomal dominant Weill-Marchesani syndrome and Marfan syndrome are allelic diseases.

Two large families with autosomal dominant Weill-Marchesani syndrome were studied. They were the same families whose condition was previously shown to be linked to chromosome 15q21.1, to the fibrillin-1 gene locus. Fibrillin-1 mutations cause Marfan syndrome, and the two syndromes are clinically similar.

In family 1 Weill-Marchesani syndrome was consistent with linkage to chromosome 15q21.1 and chromosome 19p13.3–p13.2; in family 2 linkage to chromosome 19 was excluded for all six affected members. A deletion in exon 41 of the fibrillin-1 gene was apparent in family 1, and sequence analysis showed heterozygosity for a 24 nucleotide in frame deletion, which segregated with affected family members but was not present in 186 controls of European origin. No mutation was identified in family 2, maybe because of a low rate of mutation, as in Marfan syndrome.

Affected members of both families had their DNA analysed for genetic linkage to 19p13.3–p13.2 and PCR products were sequenced for the fibrillin-1 gene for one family member initially, and other members as necessary.

Weill-Marchesani syndrome can show autosomal dominant or autosomal recessive inheritance, though the clinical features of each are identical. The investigators had already shown that autosomal recessive Weill-Marchesani syndrome mapped to chromosome 19q13.3–13.2 in two large families of Lebanese and Saudi origin. Optical features of the syndrome are microsphaerophakia, with dislocation of lenses, severe short sight, and glaucoma.

▲ *Journal of Medical Genetics* 2003;**40**:34–36.