ORIGINAL ARTICLE

Cost Analysis of Cataract Surgery With Intraocular Lens Implantation: A Single Blind Randomised Clinical Trial Comparing Extracapsular Cataract Extraction and Phacoemulsification

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Summary

A randomised single blinded clinical trial to compare the cost of cataract surgery between extracapsular cataract extraction (ECCE) and phacoemulsification (PEA) was conducted at Hospital Universiti Kebangsaan Malaysia (HUKM) between March and December 2000. A total of 60 patients were included in this study. The cost of a cataract surgery incurred by hospital, patients and households up to two months after discharge were included. The costs of training, loss of patients' income after discharge and intangible costs were excluded. Results showed that the average cost for one ECCE operation is RM1,664.46 (RM1,233.04 - RM2,377.64) and for PEA is RM1,978.00 (RM1,557.87 - RM3,334.50). During this short period of follow up, it can be concluded that ECCE is significantly cheaper than PEA by an average difference of RM 313.54 per patient ($p<0.001$). Cost of equipment and low frequency of PEA technique done in HUKM were the two main reasons for the high unit cost of PEA as compared to ECCE.

Key Words: Cataract surgery, Cost analysis, Extracapsular cataract extraction, phacoemulsification

Introduction

Cataract is the leading cause of blindness in Malaysia and worldwide, affecting more than 20 million individuals[1]. The global prevalence of blindness is 0.7%, with 0.3% in developed countries and up to 1.4% in less developed countries such as Sub-Saharan, Africa[2]. There are two techniques of cataract surgery performed in HUKM, i.e. phacoemulsification (PEA) which is relatively new and the older method of extracapsular cataract extraction (ECCE).

This article was accepted: 25 February 2003

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Compared with ECCE, PEA requires a smaller corneal incision but needs special equipment and more expensive consumables[3]. Among the advantages of PEA are faster visual recovery, lower incidence of post-operative astigmatism, early stabilization of refraction and sustained intraocular pressure control during operation[4,5].

Despite the large number of cataract surgery performed in Malaysia, very little is known regarding the costs or variation in costs between ECCE and PEA. Further more, very little is known about the effectiveness of the cataract surgery performed. Therefore, we performed this study to analyse and compare the cost of cataract surgery by ECCE and PEA in HUKM. The cost effectiveness analysis of these two techniques will be presented in another publication.

Materials and Methods

This randomised single blinded clinical trial was performed over a period of ten months, between March and December 2000 at the Ophthalmology Clinic, HUKM. A total of 60 patients were enrolled in this study. The inclusion criteria were patients aged more than 40 years old, who had best corrected visual acuity of 6/60 or better with symptoms of cataract such as blurred vision, glare, altered colour sensation and progressive myopia, and also those who underwent first cataract surgery.

There were two exclusion criteria set for this study: general and ocular factors. Patients who were difficult to assess due to mental or physical handicap such as senile dementia, frailty or deformity, have past history of eye injury, undergoing any major surgery within the study period, anxious patients who require general anaesthesia, and patients with cerebral vascular accident causing significant visual loss. Patients who exhibited signs of ocular factors such as glaucoma, maculopathy, difficult pupillary dilatation , other causes of media opacities such as vitreous haemorrhage, and have any corneal opacity encroaching the central zone of three millimeter diameter were excluded from this study.

All patients who fulfilled the above criteria were given an appointment date to be seen by the medical officers in-charge of this study. They had one clinic visit preoperatively followed by their admission to the ward, and two clinic visits post operatively. During their first clinic visit, systemic and ocular examinations were performed. Using a computer generated randomisation table, they were subjected to either ECCE or PEA.

Haematological, radiological as well as electrocardiography examinations were performed on the first visit. The costs of the preoperative and post operative clinic visits, their admission to the ward and surgical procedures were calculated and documented. Patients who had associated co-morbidity or complications following surgery were followed up more closely.

Assessment of Costs

Costs incurred by the hospital (provider) and by patients (including households costs) were imputed in the study. Provider costs were further classified into capital and recurrent costs. These costs were based on the financial year 1999.

Capital costs for provider included building, furniture and equipment costs. All capital costs were discounted at the rate of 5% per annum. The useful life of building was assumed to be 20 years while life span of furniture was five years. Life span of equipment was based on the article by Asimakis et al[6]. All equipment that cost above RM 500 were considered as capital. The total capital costs were further divided by the total number of patients using the facilities to obtain the unit cost. Vehicle cost was not included because there was no transportation used by the hospital for cataract surgery.

Recurrent cost, included in this study were personnel, consumables, laboratory investigations, drugs, administration, utility and maintenance of

equipment. Personnel costs were based on total emolument and time spent for each activity by the surgeons, doctors, nurses and attendants. Emolument of each category of personnel includes salary, allowances, overtime and bonuses received in the year 1999. Purchasing price of the consumables were used as the costs. Laboratory investigations costs were calculated based on the charges to patient by the hospital.

Costs for drugs included eye drops and other medications given in the ward, and after patient was discharged one week and two months post operation. Administration costs were an approximation, we assumed one third of the total administration personnel time was allocated to outpatients and two third for inpatients. These costs were further divided by the total number of HUKM outpatients and inpatients for the year 1999, in order to get unit cost for administration. Utility and maintenance costs were calculated based on floor space of each clinic, ward and operation theatre used in the cataract surgery activities. Training expenses in both ECCE and PEA technique was not included.

Patient costs included in this study were clinic fees, transportation, waiting time, other eye treatment expenses, co-morbidity treatment, intraocular lens implant, ward charges, cost of extra visits and household costs. Clinic fees were based on the charges by the hospital for each clinic visit. Transportation cost for patients and their relatives included the journey to and from the hospital. Waiting time for patient was calculated based on total time spent waiting in the ophthalmology clinic before seeing the doctor. The time spent was converted into cost by multiplying the number of minutes spent during the visit with patient's income in minute (monthly income divide by 10,560 : this figure is derived by multiplying the 22 working days per month by 8 working hours per day - 22 days X 8 hours X 60 minutes) . No cost was considered for unemployed patients. Cost of other eye treatment was cost incurred by patients in treating the eye problems one year before the cataract surgery. Cost of co-morbidity treatment considered in this study was calculated for a period of one year. The co-morbidities were mainly hypertension and diabetes mellitus.

Intraocular lens implant and ward charges were based on the charges by the hospital. Cost of extra visits incurred by patients included transportation cost, waiting time, extra laboratory cost and cost incurred by those who accompanied the patient during the extra visits. The household cost is the cost of time spent by a spouse or relative in the clinic while accompanying the patient. This is based on income of the spouse or relative.

Indirect cost due to loss of income for a working patient after discharge was not included in this study. This cost is difficult to assess because patients may continue to work despite medical certification of being unfit for duty especially those who are self-employed. Assessment of intangible costs, such as pain, emotional well-being and ability to interact with and support others were not included in the cost analysis.

Data Analysis

Chi-square was used to determine any difference in patients' characteristics between ECCE and PEA. In terms of costs, t-test was used to determine the difference in the average cost between the two types of cataract surgery.

Sensitivity Analysis

We performed sensitivity analysis by using different discount rate and different rate of PEA operation done in the hospital. We used 0% and 10% discount rate in sensitivity analysis to assess any changes in the cost analysis. In 1999, the PEA operation rate in HUKM was 22.4%. In sensitivity analysis, the costs were compared when PEA rate is increased to 50%.

Results

Characteristics of Patients

The socio-demographic characteristics, presence of co-morbidities, or prevalence of seeking eye treatment before the cataract surgery were homogenous in both the ECCE and PEA groups (Table I).

Table I: Patients' Characteristics

Characteristics	ECCE		PEA		p value
	No.	%	No.	%	(χ2)
Sex					
Males	12	40.0	12	40.0	1.000
Females	18	60.0	18	60.0	
Ethnicity					
Malay	14	46.7	14	46.7	1.000
Chinese	15	50.0	15	50.0	
Indian	1	3.3	1	3.3	
Age (years)					
45 - 54	3	10.0	5	16.7	0.144
55 - 64	10	33.3	12	40.0	
65 - 74	11	36.7	13	43.3	
75 - 84	5	16.7	0	0.0	
85 - 94	1	3.3	0	0.0	
Level of Education					
No formal education	12	40.0	9	30.0	0.810
Primary	14	46.7	15	50.0	
Secondary	3	10.0	5	16.7	
Tertiary	1	3.3	1	3.3	
Occupational Status					
Unemployed / Housewife	19	63.3	15	50.0	0.580
Pensioner	5	16.7	7	23.3	
Working	6	20.0	8	26.7	
Presence of Co-morbidity					
Yes	18	60.0	18	60.0	1.000
No	12	40.0	12	40.0	
Eye treatment before cataract surgery					
Yes	19	63.3	19	63.3	1.000
No	11	36.7	11	36.7	

Cataract Surgery Cost

Cost profiles of both ECCE and PEA up to two months post-operation are shown in Table II. Cost of equipment, personnel, consumables, and drugs differs significantly between the two groups of patients. Even though PEA has lower personnel and drugs cost, the cost of consumables and equipment is very much higher than ECCE. The equipment for PEA is nearly three times higher than those used in ECCE. The ECCE drugs cost is about five times higher than PEA group. Cost of intraocular lens implant is the major expense incurred by patients in both groups. It represents nearly half of the patient's cost in both groups. PEA requires patients to use a more expensive intraocular lens implant (RM30 more) than those in the ECCE group.

In terms of cost incurred by the hospital and by patients, it was found that patients had to bear a higher portion of the total cost: 61.1% in ECCE and 53.6% in PEA. The average cost of cataract surgery using PEA is about 18.8% higher than ECCE. The hospital cost for PEA exceeded ECCE by 32.4%.

Table II: Cost Profiles of ECCE and PEA Two Months Post-Operation in Ringgit Malaysia (RM)

INPUT	ECCE		PEA		p value
	Mean (Range)	S.D.	Mean (Range)	S.D.Sex	
A) Hospital Cost					
Capital Cost					
Building	58.73 (56.96-99.94)	7.99	58.78 (56.96-71.87)	3.80	0.096
Furniture	32.36 (32.32-33.29)	0.18	32.36 (32.32-32.65)	0.08	0.096
Equipment	150.75 (150.40-155.70)	1.34	434.90 (433.93-441.88)	2.03	0.000*
Recurrent Cost					
Personnel	114.22 (93.50-136.48)	11.48	88.49 (79.15-125.27)	11.39	0.000*
Consumables	128.55 (127.70-129.50)	0.35	195.50 (194.40-196.50)	0.41	0.000*
Laboratories	165.17 (125.00-335.00)	54.00	142.03 (105.00-321.00)	37.36	0.085
Drugs	59.12 (24.85-92.08)	12.77	10.86 (5.10-29.69)	3.97	0.000*
Administration	31.02 (30.26-47.81)	3.31	31.22 (30.26-38.14)	2.01	0.096
Utility and Maintenance	45.88 (44.50-78.08)	6.24	45.92 (44.50-56.14)	2.97	0.096
Total Hospital Cost	785.79 (709.04 - 914.51)	58.47	1040.08 (1005.42 - 1228.30)	43.66	0.000*
B) Patient Cost					
Clinic Fees	13.73 (0.00-57.50)	19.24	14.67 (0.00-70.00)	17.99	0.509
Transportation	52.97 (14.00-200.00)	42.41	45.19 (7.00-120.00)	28.72	0.750
Waiting Time	70.69 (0.00-498.46)	124.13	155.03 (0.00-1416.15)	305.83	0.288
Eye Treatment	5.60 (0.00-50.00)	13.25	16.00 (0.00-240.00)	45.02	0.570
Co-morbidity	54.64 (0.00-389.02)	106.85	51.99 (0.00-532.61)	104.21	0.502
Intraocular Lens Implant (fixed price)	480.00	-	510.00	-	
Ward Charges	125.20 (0.00-395.00)	119.43	107.13 (0.00-345.00)	105.81	0.347
Extra Visit	9.28 (0.00-269.23)	49.13	12.00 (0.00-103.46)	26.49	0.078
Household	205.48 (0.00-618.46)	181.06	147.73 (0.00-904.80)	217.80	0.068
Total Patient Cost	**1017.61 (574.50 - 1593.54)**	**259.42**	**1059.74 (662.10 - 2357.97)**	**426.96**	**0.626**
Total Cataract Surgery Cost	**1664.46 (1233.04 - 2377.64)**	**274.70**	**1978.00 (1557.87 - 3334.50)**	**473.12**	**0.000***

* significant at $p<0.05$

Sensitivity Analysis

Table III showed the difference in total cost between ECCE and PEA in sensitivity analysis. If the PEA is carried out in 50% of patients requiring cataract surgery in the hospital, while the ECCE rate remain constant, the average cost of PEA will drop by RM156.83 and the difference in the total cost will not be significant. However by keeping the current rate of ECCE and PEA, and using 0% and 10% discount rate, the difference between the two methods widens and remains significant favouring ECCE.

Table III: Average Total Cost (RM) of ECCE and PEA in Sensitivity Analysis

INPUT	ECCE		PEA		p value
	Mean (Range)	S.D.	Mean (Range)	S.D.	
50% PEA Activity Rate	1664.46 (1232.39 - 2378.14)	274.81	1821.17 (1401.42 - 3177.75)	473.18	0.231
0% Discount Rate	1598.79 (1166.71 - 2312.46)	274.81	1874.08 (1454.33 - 3230.66)	473.18	0.001*
10% Discount Rate	1741.85 (1309.77 - 2455.52)	274.81	2095.76 (1676.01 - 3452.34)	473.18	0.000*

* significant at $p<0.05$

Discussion

This randomised single blind study showed that cost of PEA is significantly higher than ECCE. Theoretically there are a number of advantages in carrying out PEA. The personnel and drugs costs are less because PEA can be done in relatively shorter operation time than ECCE. In this study it was found that the average operation time for PEA is 21.8 minutes compared to 43.2 minutes for ECCE. The PEA technique is also less invasive where a smaller incision is required compared to ECCE. Through this small incision, the lens nucleus is phacoemulsified using a low flow/high vacuum machine. In ECCE, the lens nucleus was expressed using bimanual technique.

The cost of the special machine is the major disadvantage of PEA technique. The average cost is higher when the volume of operation carried out using the technique is small. This is because the number of surgeons trained using PEA technique is small and hence this type of operation is not being carried out that frequently compared to ECCE.

The difference in drug treatment cost is caused by the difference in the anti-inflammatory eye drops used by both groups of patients. For PEA patients, the ophthalmologist preferred to use *Maxitrol* which cost RM2.45 per bottle whereas for ECCE patients, the ophthalmologist used *Betnesol N* that cost RM11.68 per bottle. If *Maxitrol* eye drop usage was standardized in both techniques, ECCE would be much more cheaper than PEA.

The result of this study concurs with study done by Asimakis et al.[6] in 1996 where they found that the hospital costs for ECCE without any complication was AUD 1,000.85 and for PEA was AUD 1,231.00 (AUD 1.00 = RM 2.00). However the difference in hospital costs in our study is higher than those found by Asimakis et al. In our study, the difference is 32.4% whereas in Asimakis's study the difference was only 23.0%. The explanation for the difference is that Asimakis et al. included intraocular lens implant cost in the total hospital cost and they used more disposables which were costly.

Another study which was conducted in Sweden has shown that the average cost for a cataract surgery performed at the eye clinic was 5,052 SEK (1 SEK = RM0.37)[7]. The majority of their cases (90%) were performed using the PEA technique.

The average cost of this type of cataract surgery was found to be more costly compared to our finding. This was due to the high cost for personnel, which was found to be 1,449 SEK (47.9%) of the total cost of cataract surgery performed. This is extremely high compared with that found in our study which was RM88.49 (8.5%).

The results should be interpreted taking into account the limitations of the study. The main limitation is the time-frame where cases were followed-up for just two months after operation. PEA will not require any further visits after two months. Patients who had ECCE had to undergo two more visits to remove the sutures. They are also required to be followed-up till six months for refractive error correction. So it is possible then that if the study was extended to about six months, the cost of ECCE might increase and may be higher than the PEA technique.

Another limitation is some costs that were not included in this study. For example, the cost of training the ophthalmologist in handling the PEA machine and the cost of patient's productivity loss, after being discharged from the ward. These costs were considered direct cost for the hospital as well as for the patient in the total cost of cataract surgery.

In conclusion, in the limitations mentioned earlier, ECCE technique is less costly compared to PEA. Cost of equipment and low frequency of the PEA technique done in HUKM are the two main reasons for the high unit cost of PEA compared to ECCE. However in the long term, it is likely that PEA cost will be less compared to ECCE. The effectiveness of cataract surgery is also one of the aspects that should be considered in order to determine which technique is more cost effective.

Acknowledgements

We would like to acknowledge the contributions of the staff of Hospital Universiti Kebangsaan Malaysia directly or indirectly in this study. This study was funded by the Intensification of Research in Priority Areas (IRPA) Project No. 06 - 02 - 02 - 0106, grant from the Ministry of Science, Technology and Environment, Malaysia.

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