

Cataract surgical quality and cost in a hill region of Western Nepal: comparing outreach eye camps with base hospital



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ABSTRACT

Background: Base hospitals that provide cataract surgical services in outreach settings need evidence that the cataract surgical quality is maintained in the camp setting and that patients achieve cost savings. **Aims and Objective:** To know whether the same quality cataract surgical care could be maintained in the Primary Eye Care Centres (PECCs) as the base hospital. **Material and Methods:** A prospective study at was carried out at Palpa Lions Lacoul Eye hospital (PLLEH) Gulmi, Arghakhanchi and Rampur PECCs. Total 1038 patients were examined and admitted one day prior to or on the same day of surgery. All patients were examined first post-operative day and after 2 - 3 weeks. Surgical complications, Visual acuity(VA) at discharge, 2-3 weeks were reported. **Result:** Out of 1038 patients, the male patients were 556 (53.6%) and females were 482 (46.4%). Five hundred six eyes (47.2%) had VA <3/60 and 179 eyes (16.7%) had VA <6/60-3/60 and 385 eyes (36%) had <6/18-6/60 preoperatively. On first postoperative day, 853 eyes (80%) had good, 144 (13 %) had borderline and 74 (7 %) had poor outcome. 5.6% eyes had intra-operative complications. On day one, Arghakhanchi had significantly worse ($p < 0.05$) Gulmi not significantly different and Rampur significantly better ($p < 0.05$) VA compared to PLLEH. Cost per surgery was \$25 for PLLEH, \$37 for Arghakhanchi, \$54 for Gulmi, and \$ 62 for Rampur respectively. **Conclusions:** The same quality and cost saving cataract surgery can be attained primary eye care centers as base hospital. Application of better patient selection criteria will reduce intra-operative complications in the PECCs.

Key words: Manual small incision cataract surgery, Base hospital, Eye camps

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INTRODUCTION

Cataract is the most common cause of severe low vision and blindness globally with the highest burden in developing countries especially in South East Asia, including Nepal, where it accounts for 74 % of blindness.^{1,2} Increasing life expectancy and low uptake of cataract surgical services are contributing to an ever increasing number of untreated cataract patients in many settings leading to a public health problem.³

In Nepal, approximately 90% of the hill population lives in widely scattered villages, accessible only by foot. In

order to serve these remote populations, the Palpa Lions Lacoul Eye Hospital (PLLEH) in Tansen established a network of permanent affiliated community eye care facilities known as Primary Eye Care Centres (PECCs). A PECC has sophisticated ophthalmic equipment including a slit lamp and refraction devices (some with auto-refractors) and are staffed by well trained ophthalmic assistants that can effectively deal with about 85 to 90% of eye conditions. More complicated conditions needing surgery, particularly cataract are referred to the base hospital for care.

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Over time, the larger and more frequently used PECCs have become District PECCs with their own affiliated smaller PECCs. The District PECCs were modified to accommodate surgical procedures in their facilities, conducted during regular (usually monthly) visits by the PLLEH ophthalmologist and hospital staff. One other PECC, in a remote location, was also modified to facilitate visiting surgical services.

PLLEH assumed that the surgical camps in local PECCs would increase service utilization by marginalized people, particularly women, thereby reducing avoidable blindness in the region. Of concern to PLLEH was whether the same quality cataract surgical care could be maintained in the PECCs as the base hospital and whether the cost to the hospital of providing that surgery is justified by the cost savings to the people receiving surgery much closer to home.

MATERIALS AND METHODS

This prospective cross-sectional study enrolled patients age 50 years and older who underwent routine manual small incision cataract surgery between May 15 2015 to May 14 2016. Exclusion criteria were patients with complicated, traumatic, uveitic or developmental cataract.

The study was conducted in accordance with the tenets of the Helsinki declaration. Ethical approval was obtained from the Institutional Research Review Board of Lumbini Eye Institute. A written informed consent was obtained.

Patients were admitted one day prior to or on the same day of surgery and discharged on the next day. A study performa was designed and attached to the surgical card before surgery.

The same technician calculated intra-ocular lens power in all settings using contact A-scan biometry. The same technician measured corneal thickness using a hand held -Keratometer (Nidek KM 500) in the PECCs and a TOPCON OM-4 in the base hospital. Ophthalmic assistants¹ or eye care workers measured visual acuity and intra-ocular pressure (schiotz tonometer). B-scan (ocular ultra-sonography) was not available in any setting.

A single ophthalmologist performed all the cataract surgery using manual small incision surgical technique with a superior approach under peri-bulbar anesthesia. Single-piece polymethylmethacrylate intraocular lenses (PMMA IOL) were inserted (ranging from 18D to 28D of lens). No

sutures were placed in uncomplicated cases and all were given a sub-conjunctival injection with a combination of gentamycin and dexamethasone.

The ophthalmologist examined all patients on postoperative day 1 and after 2 to 3 weeks with a slit-lamp.

All patients received the same postoperative combination of chloramphenicol (1%) and Dexamethasone (0.1%) eye drops every one hourly from day 1 till day 8, every 2 hours in the 2nd week, and gradually tapering for another 4 weeks.

The primary outcome measure was post-operative, pinhole corrected VA on day 1 and 2-3 weeks. The secondary outcomes were intra and post-operative complications as well as the overall costs of cataract surgery considering both patients and eye care program.

Visual acuity (VA) was categorized using the WHO guidelines: good 6/6 to 6/18, borderline 6/18 to 6/60, and poor less than 6/60. Pre-operative VA was best corrected (either using pin hole or refraction). All the post-operative VAs on day one and at 2-3 weeks were pin hole corrected because refraction was only done after 6 weeks in this setting.

The sample size estimate assumed that both the base hospital and PECC would obtain good (pinhole > 6/18) VA in 80% of eyes on discharge (100% of eyes examined). The sample assumed the ability to detect a 5% difference between base hospital and PECCs with 80% power and a 95% confidence interval. Exact chi-square test was used to compare frequencies using SPSS 16.0.

Eye care program cost estimates included: 1) medical and surgical consumables which were taken as the same in PLLEH and the PECCs; 2) salary estimates for PLLEH based on 11 staff per surgical, ECCs used 6 staff per surgical day, with most camps occupying 3 days including travel time; 3) travel calculated by distance from PLLEH; accommodation was free because staff stay at the PECCs. 4) Others costs for camps included publicity and educational pamphlets and posters, vehicle maintenance.

Patient cost estimates included: 1) travel and food for patient and companion based on time and distance 2) accommodation is free at the hospital; 3) wages lost for patient and companion were based on government norms of Rupees 400/day.

RESULT

Manual small incision cataract surgery was performed on 1205 patients, PLLEH (350) Arghakhanchi (330) Gulmi (285) Rampur (240). Of these, 1038 patients met study criteria; male 556 (53.6%) and female 482 (46.4%); mean age of 69.7 ± 9.1 years (range 50 to 97 years). The 167 excluded patients were uveitic cataract (56), traumatic cataract (30), developmental cataract (25) and phacomorphic glaucoma (56). Of the included patients 1005 (96.8%) had unilateral and 33 (3.2%) had bilateral surgery for a total of 1071 operated eyes (Table 1).

The majority of eyes had corticonuclear (51.8%) or mature (24.2%) cataract. The proportion of eyes with different types of cataract was similar in base hospital and PECCs (Table 2).

Pre-operatively, 506 eyes (47.2%) had VA <3/60, 179 eyes (16.7%) had VA <6/60-3/60 and 385 eyes (36%) had <6/18-6/60. Gulmi and Arghakhanchi had significantly better VA at baseline compared to PLLEH ($p < 0.05$) (Table 3).

On post-operative day one, 853 eyes (80%) had good, 144 (13 %) borderline and 74 (7 %) had poor outcome. Arghakhanchi had significantly worse ($p < 0.05$) Gulmi not significantly different and Rampur significantly better ($p < 0.05$) VA compared to PLLEH (Table 4).

At 2-3 weeks postoperatively 847 (79.1) eyes had good, 49 (4.6%) borderline and 14 (1.3%) had poor VA. Compared with the base hospital, the VA outcome was significantly better in Gulmi ($p < 0.05$) and not significantly different in Arghakhanchi or Rampur (Table 5).

Table 1: Demographic profile of the patients by age, sex, and location

	N %				
	PLLEH	Gulmi	Arghakhanchi	Rampur	Total patients
Age (Yrs)					
50-60	52	40	44	35	171 (16.5)
61-70	91	82	100	88	361 (34.7)
71-80	100	108	104	74	386 (37.1)
>80	49	27	21	23	120 (11.6)
Total	292 (100)	257 (100)	269 (100)	220 (100)	1038 (100)
Sex					
Male	150	152	154	100	556 (53.6)
Female	142	105	115	120	482 (46.4)
Total	292 (100)	257 (100)	269 (100)	220 (100)	1038 (100)

Table 2: Cataract type in operated eye by site

Cataract type	N %				
	PLLEH	Gulmi	Arghakhanchi	Rampur	Total Eyes
Mature	72 (23.5)	68 (24.5)	51 (19.5)	68 (30.1)	259 (24.1)
Hypermature	7 (2.2)	13 (4.7)	5 (1.9)	5 (2.2)	30 (2.8)
Corticonuclear	159 (51.8)	137 (49.5)	145 (55.6)	114 (50.4)	555 (51.8)
PSCC	43 (14.0)	38 (13.7)	49 (18.8)	28 (12.4)	158 (14.8)
Brunescent	26 (8.5)	21 (7.6)	11 (4.2)	11 (4.9)	69 (6.5)
Total eyes	307 (100)	277 (100)	261 (100)	226 (100)	1071 (100)

Table 3: Presenting VA of operated eye by site

Distance VA	N %				
	PLLEH	Gulmi*	Arghakhanchi**	Rampur	Total
6/6-6/18	0 (0)	0 (0)	1 (0.3)	0 (0)	1 (0.1)
<6/18-6/60	89 (29.0)	110 (39.7)	110 (42.2)	76 (33.6)	385 (36.0)
<6/60-3/60	59 (19.2)	46 (16.6)	43 (16.5)	31 (13.7)	179 (16.7)
<3/60	159 (51.8)	121 (43.7)	107 (41.0)	119 (52.7)	506 (47.2)
Total	307 (100)	277 (100)	261 (100)	226 (100)	1071 (100)

* **Arghakhanchi significantly worse VA versus base hospital ($p < 0.05$)

* Gulmi significantly better VA versus base hospital ($p < 0.05$)

Among all operated eyes, 5.6% had intra-operative complications. Posterior capsular rupture did not occur in base hospital but occurred in 7 eyes in PECCs. On post-operative day 1, all 7 eyes had VA <6/60. At 2-3 weeks follow up, 4 eyes had VA <6/60, 2 eyes had VA 6/18 to 6/60 and 1 patient was lost to follow up.

The most common intra-operative complication was premature entry in 23 eyes (2.1%). The frequent complications during the immediate postoperative period were striate keratopathy (7.0%), corneal edema (5.1%) and hyphema (1.5%). Most of corneal edema and striate keratopathy were resolved within 2-3 weeks with good to borderline VA. Twenty-one patients underwent manipulation on the first post-operative day in the PECCs. Among them, 10 eyes underwent hyphema wash, 6 had sclero-corneal tunnel suturing for wound leak and 5 needed pad and bandage for corneal epithelial defect (Table 6).

At 2-3 wks follow up 10 eyes had corneal edema and 15 striate keratopathy. None of the eyes needed additional

treatment. There were no cases of endophthalmitis (Table 7).

Cataract surgical productivity:

- Arghakhanchi: 6 camps, 261 surgeries = 43 operations/camp
- Gulmi 12 camps, 271 surgeries = 23 operations/camp
- Rampur 11 camps, 226 surgeries = 20 operations/camp
- PLLEH 21 surgical days for 307 surgeries = 15 operations/day

The total costs (surgical and team travel) to conduct cataract surgery were \$7,707, \$9,546, \$14,848, and \$13,964 for PLLEH, Arghakhanchi, Gulmi and Rampur, respectively. The higher PECC costs primarily reflect salaries incurred during non-productive staff travel days (Table 8).

The costs per case were estimated at \$25, \$37, \$54, and \$ 62 for PLLEH, Arghakhanchi, Gulmi, and Rampur,

Table 4: Day 1 post-operative VA of operated eye by site

Distance VA	N %				
	PLLEH	Gulmi	Arghakhanchi**	Rampur	Total
6/6-6/18	236 (76.9)	224 (80.8)	202 (77.4)	191 (84.5)	853 (79.7)
<6/18-6/60	57 (18.6)	34 (12.3)	33 (12.6)	20 (8.8)	144 (13.4)
<6/60	14 (4.5)	19 (6.9)	26 (10.0)	15 (6.7)	74 (6.0)
Total	307 (100)	277 (100)	261 (100)	226 (100)	1071 (100)

* Arghakhanchi significantly worse VA versus base hospital (p<0.05)

* Rampur significantly better VA versus base hospital (p<0.05)

Table 5: Day 14-21 post-operative VA of operated eye by site

Distance VA	N %				
	PLLEH	Gulmi*	Arghakhanchi	Rampur	Total
6/6-6/18	252 (82.1)	218 (78.8)	201 (77.0)	176 (77.9)	847 (79.1)
<6/18-6/60	29 (9.5)	2 (0.7)	8 (3.1)	10 (4.4)	49 (4.6)
<6/60	1 (0.3)	3 (1.0)	6 (2.3)	4 (1.8)	14 (1.3)
Lost to follow up	25 (8.1)	54 (19.5)	46 (17.6)	36 (15.9)	161 (15.0)
Total	307 (100)	277 (100)	261 (100)	226 (100)	1071 (100)

* Gulmi significantly better VA versus base hospital (p<0.05)

Table 6: Intra operative complications by site

Intra-operative complications	N %				
	PLLEH	Gulmi	Arghakhanchi	Rampur	Total
None	301 (98)	257 (92.7)	242 (92.7)	211 (93.4)	1011 (94)
PCR IOL sulcus	0 (0)	1 (0.1)	1 (0.1)	0 (0)	2 (0.2)
PCR with ACIOL	0 (0)	0 (0)	1 (0.1)	0 (0)	1 (0.1)
PCR with NO IOL	0 (0)	0 (0)	2 (0.2)	1 (0.1)	3 (0.3)
PCR+NO IOL+iridodialysis	0 (0)	1 (0.1)	0 (0)	0 (0)	1 (0.1)
DM stripping	3 (0.3)	5 (0.4)	4 (0.4)	2 (0.2)	14 (1.3)
Zonular dialysis	0 (0)	2 (0.2)	1 (0.1)	2 (0.2)	5 (0.5)
Iridodialysis	2 (0.2)	3 (0.3)	2 (0.2)	4 (0.3)	11 (1.0)
Premature entry	1 (0.1)	8 (0.7)	8 (0.7)	6 (0.6)	23 (2.1)

Table 7: Post operative complication day one

Post-operative complications	N %				
	PLLEH	Gulmi	Arghakhanchi	Rampur	Total
None	275 (89.6)	233 (84.1)	216 (82.8)	185 (81.8)	909 (84.8)
Corneal edema	10 (3.3)	14 (5.1)	18 (6.9)	13 (5.8)	55 (5.1)
Striate Keratopathy	17 (5.5)	18 (6.5)	20 (7.7)	20 (9.0)	75 (7.0)
Hyphema	3 (1.0)	5 (1.8)	4 (1.5)	4 (1.8)	16 (1.5)
Epithelial Defect	1 (0.3)	3 (1.1)	0 (0)	1 (0.4)	5 (0.5)
Peaked pupil	0 (0)	3 (1.1)	1 (0.4)	1 (0.4)	5 (0.5)
Wound leak	1 (0.3)	1 (0.3)	2 (0.7)	2 (0.8)	6 (0.6)
Lost to follow up	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total Eyes	307 (100)	277 (100)	261 (100)	226 (100)	1071 (100)

Table 8: Cost of cataract surgery by site (USD)

	PLLEH	Arghakhanchi	Gulmi	Rampur
Material	1,927	1,927	1,927	1,927
Logistics	1,866	1,866	1,866	1,866
Salary	3,463	5,302	10,605	9,721
Other	450	450	450	450
Total cost	7,707	9,546	14,848	13,964

respectively. The additional costs to PLLEH of providing cataract surgery in the PECCs were \$12, \$29, and \$37 for Arghakhanchi, Gulmi and Rampur, respectively. Patient costs incurred if they had traveled to PLLEH to undergo cataract surgery were estimated as \$80, \$82, and \$80 for Arghakhanchi, Gulmi and Rampur respectively. The net effect were system savings (estimated patient costs minus addition PLLEH costs of providing PECC surgery) were \$68, \$53, and \$43 for Arghakhanchi, Gulmi, and Rampur, respectively resulting in total system savings of \$41,829 (Table 9).

DISCUSSION

In this study pinhole corrected (VA) following cataract surgery was the same or slightly better in the Primary Eye Care Centres (PECCs) compared to the base hospital on the first post-operative day and after 2-3 weeks. A similar study in the adjacent Seti zone of Nepal also found no significant difference of uncorrected and best corrected VA following cataract surgery between PECCs and base hospital on the first post-operative day and at 4-6 weeks.⁴

An Indian study reported that best corrected VA after refraction at about 6 weeks after surgery was much better at the base hospital (82.7% > 6/18) compared to peripheral eye camps (43.7% > 6/18).⁵ This VA outcome at base hospital was similar to our study at 2-3 weeks in both the base hospital (82.1% > 6/18) and PECCs (77.9% > 6/18). The lower VA in surgical camps in India is almost certainly

due to poorer surgical technique used in the camps (intra-capsular cataract extraction).

In our study, pinhole corrected VA $\geq 6/18$ remained the same at day one and 2-3 weeks, (79.7% and 79.1% respectively). A similar study in Nepal reported that uncorrected VA $\geq 6/18$ declined from 76.8% day one post-operative to 70.5% at 4-6 weeks.⁶ The reasons for decreasing VA were uncorrected refractive error and surgically induced astigmatism.

Follow up at 2-3 weeks in our study was 92% at base hospital but only 82% at PECCs. This is likely because patients attending PLLEH live closer to the hospital than PECC patients, they have greater family income and better transportation. Follow-up at PECCs at 2-3 weeks in our study was higher than a study that showed only 43% follow up at 4 weeks.⁷

Despite active outreach programs designed to facilitate use of services by women, our study still served a majority of (52.2%), although the gender disparity in this study was much less than other studies in the region.^{4,6,7,8} This gender disparity underlines the need to provide more active outreach activities to reduce the financial and cultural barriers faced by women. In this setting these outreach activities involve working with mother's group leaders and Female Community Health Volunteers. In other settings in India women now receive services more commonly than men.^{5,8}

A total of 6% of patients had intra-operative complications in our study with premature entry being the most common (2.1%). All of these patients had good to borderline final pinhole VA at both base hospital and PECCs. A Pakistani study⁹ showed that 7.8% had intra-operative or immediate post-operative complications with hyphaema (4.2%) the most common (Zaman et al).¹⁰ In our study, hyphaema (16 eyes; 1.5%) was a post-operative complication.

Table 9: Cost per cataract surgical case by site (USD)

	PLLEH	Agrahakhanchi	Gulmi	Rampur
Total surgery	307	261	271	226
Total camps	0	6	12	11
Cataract/camp		43	23	20
Cost per surgery	25	37	54	62
Additional cost to PLLEH	0	12	29	37
Patient cost to travel to PLLEH	0	80	82	80
System savings	0	68	53	43
Total savings	0	17,748	14,363	9,718

Posterior capsular rupture was observed in 7 eyes (0.7%) in PECCs but not in base hospital. The likely reason include inadequate operation theatre setup, poorly illuminated portable microscope and lack of microsurgical facilities. In all 7 eyes, open sky vitrectomy was done with IOL implantation in sulcus in 2 eyes. All eyes had borderline to poor final pinhole VA.

A nearby hospital reported that 5.8% had intraoperative complications, with posterior capsular rupture (3.9%) the most common (Limbu *et al.*).¹¹ Studies in India and Nepal reported higher incidence of posterior capsular rupture 1.9%, 3.63% and 20.5% than our study.^{8,10,12}

In our study, 15% eyes had postoperative complication on day one (3.8%, 4.2%, 4.0%) in Gulmi, Arghakhanchi and Rampur and PLLEH (3.1%). None of the post operative complications were associated with poor visual acuity at 2-3 weeks follow-up. Three studies reported lower post operative complications of 9.3%, 9.3% and 6.2% respectively.^{6,8,11} Higher post operative complications in our studies were probably due to inappropriate use of viscoelastics and learning curve of the operating surgeon.

Conducting cataract surgical eye camps near to patients' homes provides substantial savings to patients primarily by avoiding the costs of travel. Estimates of patients' savings beyond the cost of providing the surgery have not reported elsewhere. If surgical quality can be maintained in the local PECC, these cost savings should be considered an important factor in program planning in a setting. More and more, programs are referring patients to the base hospital for surgery without considering the direct cost to patients.

Limitations of the study

The limitation of the study was the short term follow up and the inability to compare best corrected visual acuity and surgically induced astigmatism between the base hospital and the PECC.

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CONCLUSION

Similar quality and less costly (to community) cataract surgery can be provided in both PECCs and base hospital with the application of appropriate surgical techniques and standardized protocols. However, more attention needs to be paid over case selection in PECCs with referral of difficult and complicated cases to the base hospital. These findings have significant implications to the developing countries like Nepal to reduce the backlog of cataract blindness from remote areas.

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Author's Contribution:

LDM- Concept and design of the study, reviewed the literature, collected data, and revision of manuscript; **SKC**- Concept of study, editing the manuscript; **KB**-Reviewed the literature and revision of manuscript; **RPK**- Design of the study; **PS**- statistically analyzed and interpreted the study; **KeB**-Concept and design of the study and critical revision of the manuscript.

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