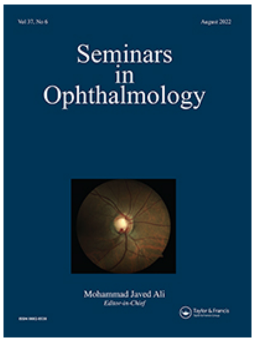

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RESEARCH ARTICLE

A Comparison of the Long-Term Surgical Outcomes of Horizontal Strabismus Surgery between Resident Clinic and Private Clinic Patients

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ABSTRACT

Purpose: To compare the long-term surgical outcomes of patients with horizontal strabismus whose surgery was performed in an outpatient department (OPD) setting (by residents-in-training) to those whose surgery was performed in a private clinic (PC) setting (by staff-ophthalmologists) in the same operating room/institution.

Methods: Two hundred and forty-four patients' charts who had horizontal strabismus surgeries from January 2007 to 2020 were reviewed retrospectively. A total of 92 patients were operated on by residents and followed in OPD, and 152 patients by staff-surgeons and followed in PC. Demographic data and eye exam parameters were collected. Distance and near deviation (in prism diopters, PD) were extracted and compared between groups at baseline and postoperatively (6 months and yearly for up to 6 years). Success was defined as a postoperative motor alignment of 10PD or less.

Results: The mean age of the 244 patients was 10.5 ± 11.7 years, with no significant differences between groups. A longer follow-up duration was reported in the PC group (34.9 ± 24.3 months vs 25.3 ± 20.2 months). Patients had similar success rates in both groups in the early postoperative period (6 months and 1 year); however, a higher success rate was observed in the PC group compared to OPD at 3, 5 and 6 years with the following respective values: 72.2% vs 50% ($p < .001$), 75% vs. 66.7% ($p = .02$), and 68.6% vs. 66.7% ($p = .03$). The difference was more pronounced in the esotropia subgroup mostly at 3 years follow-up.

Conclusion: This study showed a similar success rate of horizontal strabismus surgery performed in a PC setting by staff surgeons as compared to that performed in an OPD setting by residents at 6 months and 1 year. A significantly higher success rate was observed at long term follow-up (after 2 years) in the PC group compared to the OPD group, possibly related to the difference in compliance with post-operative follow-up management and not to surgery itself.

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Esotropia; extraocular muscles; residents; strabismus; success rate; surgery outcome

INTRODUCTION

Differences in healthcare outcomes between private and outpatient/public settings have been reported in previous studies. Moore et al., in a multi-center cohort study, found that individuals of low socio-economic status often needed longer length of hospital stay following injury.[1] Wang et al. assessed the effect of low socioeconomic status on the outcomes of cataract surgery. Their study revealed that in countries with lower human development indices (a measure of both the social and economic level), the percentage of poor visual outcomes was greater.[2] Outpatient departments are common in academic medical institutions, where residents have a major role in treating the patients as part of their training curriculum.[3] Therefore, surgeon role is another factor when comparing outcomes in this setting.

Patient attitudes about the involvement of residents in surgical procedures are inconsistent. Patients are frequently apprehensive about having residents-in-training performing a procedure on them for the first time and most would like to be informed when this is the case.[4] Several studies have attempted to investigate patient outcomes in the hands of residents in outpatient departments. A 2012 systematic review of 97 articles from different medical specialties looked into this topic and concluded that patient care generally seemed to be of equal safety and quality when delivered by residents.[5] In the field of ophthalmology, resident versus experienced surgeon (attending) surgical success rates of various procedures including trabeculotomy, penetrating keratoplasty, blepharoptosis repair, and cataract surgery have been explored.[6–10] Conclusions mostly showed a non-inferiority of resident-involved patient care in terms of surgical outcomes[5–10] and complication rate.[11]

Only a few studies have compared the surgical success rates of supervised residents performing strabismus surgery to attendings working independently.[12–14] Although all three studies reported no significant difference in surgical outcomes,[12–14] one reported a higher perioperative complication rate among resident surgeries, including accidental scleral perforation, slipped muscle and exposed/extruded tenons.[12] Knowledge about strabismus and its surgical management remains poor in certain countries.[15] In developed countries, parental opinion on the involvement of trainees has been mostly positive.[16,17] Our aim in this study was to compare the surgical outcomes of patients with horizontal strabismus whose surgery was

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performed in an outpatient department setting (OPD, where a resident was the primary surgeon) to those whose surgery was performed in a private clinic setting (PC, where a staff Ophthalmologist was the primary surgeon) in the same operating room at a single academic institution.

METHODS

Study Population

This study was approved by the Institutional Review Board (IRB) at our medical center and abided by the tenets of the Declaration of Helsinki. Informed consent was waived due to the retrospective nature of the study. Surgery billing codes were used to acquire the list of potential patients. Charts with a follow-up of less than 6 months and those with incomplete data were excluded. Patients with a predominantly vertical strabismus or those presenting for nystagmus repair (Kestenbaum procedure) were likewise excluded from the study. Two hundred and forty-four complete charts of patients who had undergone horizontal strabismus surgeries from January 2007 to January 2020 were reviewed. They were then divided into 92 patients who presented to the outpatient department (OPD), where residents examined all patients staffed by attending physicians, and the residents were the primary surgeons; and 152 patients who presented to the private clinics (PC) and had an attending as their primary surgeon. Demographic parameters recorded included gender, age, past surgeries, ophthalmological and non-ophthalmological disorders, and type of surgery performed (unilateral recession and/or resection versus bilateral rectus recession).

Eye Exam

All patients were extensively examined both pre- and post-operatively. Recorded visit parameters included visual acuity, slit lamp and fundoscopy examinations, motility exam, and cycloplegic refraction. Motility examinations were carried out twice: first by an orthoptist (in the PC) or a resident (in the OPD), followed by the attending ophthalmologist. The maximum angle of deviation was measured in prism diopters (PD) using alternate cover testing (APCT). Diagnosis of strabismus type and subtype was determined by the attending ophthalmologist after examination and documented in the medical record. Patients were categorized into having esotropia (ET) or exotropia (XT). For esotropia, diagnosed subtypes were: accommodative ET when the patient had esotropia partially corrected with hyperopic glasses, congenital ET when the patient presented with large angle ET before 1 year of life and without significant hyperopia, and intermittent ET for esotropia with intermittent control. For exotropia, diagnosed subtypes were: intermittent XT (the most common type), consecutive XT (after esotropia correction surgery), sensory XT (due to poor vision in one eye), and congenital XT (when a patient presented with constant XT before 1 year of life).[18] Visual acuity in preverbal children was tested using the “central, steady & maintained” criteria and vision charts were used for verbal children (Snellen Charts and Allen pictures). Cyclopentolate 1% and Mydriacyl 1% (applied twice 10 minutes apart) were used to achieve complete cycloplegia for fundoscopy and manual retinoscopy. If patients had a visual acuity difference of at least two lines between fellow eyes, they were marked as amblyopic.

Surgeries and Outcomes

All surgeries were completed in the operating room (OR) in the same institution with equally trained OR personnel. The attending physician prior to each surgery confirmed the pre-operative examination and decided on the surgical plan for each patient. Surgeries were further divided into esotropia and exotropia to check for predictive factors. Patients underwent either unilateral resection and recession surgeries or bilateral rectus recession surgeries to correct the horizontal strabismus. Three staff surgeons (fellowship trained in pediatric ophthalmology) performed all the surgeries using a similar technique and the same three surgeons staffed the residents who were all in their second year of residency (36 residents). A limbal approach was used unless conjunctival scarring prevented limbal dissection. The rectus muscle was hooked; a double armed 6–0 Vicryl suture was interwoven in the muscle tendon at 1 mm from its scleral insertion (for recession/ advancement surgery) or in the muscle belly at the planned resection length (for resection surgery) and double locked on each side. The muscle was then detached from the globe and reattached directly to sclera at the recession site or at the muscle insertion site. Topical antibiotic and steroid drops were given post-operatively for 2 weeks. A post-operative deviation angle of 10 prism diopters or less as measured by the alternate prism cover test (APCT) was defined as surgical success.

Analysis

Data was entered into SPSS V25 (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp., USA). For continuous demographic and eye examination parameters, means and standard deviations were calculated. Success rates were computed for OPD patients and PC patients separately, and a chi-square test was used to compare the results between them, Fisher’s exact test was used when more than 20% of cells had expected frequencies < 5. A p-value of 0.05 or less was considered statistically significant. A Kaplan–Meier survival curve was used to illustrate the success of strabismus surgery for both groups (OPD vs PC groups).

RESULTS

The cohort consisted of 244 patients divided into 92 OPD patients and 152 PC patients. The mean age of the entire group was 10.5 ± 11.7 years, with no significant differences between the OPD and PC groups. Table 1 portrays the initial visit parameters of both groups, PC patients had a longer follow-up duration than OPD patients (34.9 ± 24.3 months versus 25.3 ± 20.2 months, respectively, p = .001). Other baseline characteristics were similar (gender ratio, spherical

Table 1. Initial visit parameters and demographics.

	Total n = 244	Outpatient Department n = 92	Private Clinics n = 152	p-value
Age (Years; mean ± SD*)	10.5 ± 11.7	10.2 ± 10.8	10.8 ± 12.2	0.71
Gender Ratio (M †:F ‡)	1: 1	1: 1.1	1.1: 1	0.43
Spherical Equivalent Right (Diopters; mean ± SD*)	1.7 ± 3.4	1.8 ± 3.2	1.7 ± 3.5	0.86
Spherical Equivalent Left (Diopters; mean ± SD*)	1.8 ± 3.1	2.0 ± 3.0	1.7 ± 3.2	0.46
logMAR vision Right (mean ± SD*)	0.2 ± 0.2 n = 170	0.2 ± 0.2 n = 65	0.1 ± 0.2 n = 105	0.06
logMAR vision Left (mean ± SD*)	0.2 ± 0.2 n = 165	0.2 ± 0.2 n = 59	0.2 ± 0.3 n = 106	0.15
Distance Deviation (Prism Diopters; mean ± SD*)	31.3 ± 14.3	32.6 ± 17.7	30.5 ± 11.9	0.33
Near Deviation (Prism Diopters; mean ± SD*)	33.1 ± 14.9	34.9 ± 18.0	32.0 ± 12.6	0.18
Follow-Up Duration (months; mean ± SD*)	31.3 ± 23.3	25.3 ± 20.2	34.9 ± 24.3	0.001
Amblyopia n (%)	39 (16%)	11 (12%)	28 (18%)	0.21

*SD: standard deviation; † M: males; ‡ F: females

Table 2. Strabismus Characteristics of the study patients.

		Total n = 244	Outpatient Department n = 92	Private Clinics n = 152	p-value
Strabismus Types	Esotropia	152 (62%)	57 (62%)	95 (63%)	0.9
	Exotropia	92 (38%)	35 (38%)	57 (37%)	
Esotropia subtypes	Accommodative	60 (39%) n = 152	20 (35%) n = 57	40 (42%) n = 95	0.04
	Congenital	58 (38%) n = 152	18 (32%) n = 57	40 (42%) n = 95	
	Intermittent	1 (1%) n = 152	0 (0%) n = 57	1 (1%) n = 95	
	Other	33 (22%) n = 152	19 (33%) n = 57	14 (15%) n = 95	
Exotropia subtypes	Intermittent	50 (54%) n = 92	17 (49%) n = 35	33 (58%) n = 57	0.29
	Consecutive	17 (19%) n = 92	6 (17%) n = 35	11 (19%) n = 57	
	Sensory	8 (9%) n = 92	6 (17%) n = 35	2 (4%) n = 57	
	Congenital	5 (5%) n = 92	2 (6%) n = 35	3 (5%) n = 57	
	Other	12 (13%) n = 92	4 (11%) n = 35	8 (14%) n = 57	

equivalent, visual acuity, amblyopia and angle of deviation). In total, 39 patients (16%) had amblyopia: 28/152 PC patients (18%), and 11/92 OPD patients (12%), with no statistically significant difference between the 2 groups (p = .21).

Regarding strabismus characteristics, Table 2 shows the distribution of patients according to strabismus type (esotropia and exotropia) as well as the subtypes of each. There was no statistically significant difference between the distributions of both groups into esotropia vs exotropia (p = .9) or between the distribution of exotropes of the 2 groups into their respective subtypes (intermittent, consecutive, sensory, congenital, other, p = .29). However, there was a significant difference between the distribution of the esotropia subtypes (accommodative, congenital, intermittent, other, p = .04). The PC group had more congenital and accommodative ET patients while the OPD group had more other ET diagnoses (including sensory ET, cranial nerve (CN) VI palsy, and Duane syndrome)

The final visit parameters of the cohort are shown in Table 3. There were no differences between groups in visual acuity, and spherical equivalent. However, PC patients had a smaller distance angle of deviation (5.3 ± 7.0 PD versus 8.7 ± 9.9 PD, p = .006). This pattern was also seen for the near angle of deviation (p = .02). Table 4 compares the surgical success rates of both groups computed at different time points. At 6 months, 1 year, and 2 years, the success rate for the whole group was 69.5%, 74.1% and 67.3% with no statistically significant differences seen between the two groups. However, long-term success rates differed with patients from PC having a higher success rate than those from the OPD group. This was statistically significant at 3, 5 and 6 years with the following respective values: 72.2% vs 50% (p < .001), 75% vs. 66.7% (p = .02), and 68.6% vs. 66.7% (p = .03), but not at the 4 year time point (Table 4). This difference was significant after one surgery, but not after 2 or more surgeries. Five percent of PC patients required 2 surgeries, compared to 7% of OPD patients, and 3% of PC patients required 3 surgeries compared to none from the OPD group. However, these differences were not statistically significant. A greater proportion of OPD patients were overcorrected compared to PC patients (12% vs 9% respectively); however, this difference did not reach statistical significance. A Kaplan–Meier survival curve illustrates the change in success of strabismus surgery over time in both

Table 3. Final visit parameters.

	Total n = 244	Outpatient Department n = 92	Private Clinics n = 152	p-value
Spherical Equivalent Right (Diopters; mean ± SD*)	1.5 ± 3.2	1.6 ± 3.2	1.4 ± 3.3	0.71
Spherical Equivalent Left (Diopters; mean ± SD*)	1.5 ± 3.5	1.6 ± 3.5	1.5 ± 3.5	0.79
logMAR vision Right (mean ± SD*)	0.2 ± 0.2 n = 207	0.2 ± 0.2 n = 69	0.2 ± 0.2 n = 138	0.28
logMAR vision Left (mean ± SD*)	0.2 ± 0.3 n = 209	0.2 ± 0.3 n = 71	0.2 ± 0.2 n = 138	0.11
Distance Deviation (Prism Diopters; mean ± SD*)	6.6 ± 8.3	8.7 ± 9.9	5.3 ± 7.0	0.006
Near Deviation (Prism Diopters; mean ± SD*)	7.5 ± 8.3	9.4 ± 10.1	6.4 ± 7.0	0.02

*SD: standard deviation

Table 4. Surgical success rates for horizontal strabismus surgery for outpatient department (OPD) vs private clinic (PC) patients at different time points.

Success rate	Total n = 244	OPD n = 92	PC n = 152	p-value
6 months	114 (69.5%) n = 164	36 (62.1%) n = 58	78 (73.6%) n = 106	0.18
1 year	120 (74.1%) n = 162	42 (80.8%) n = 52	78 (71%) n = 110	0.61
2 years	70 (67.3%) n = 104	23 (65.7%) n = 35	47 (68.1%) n = 69	0.52
3 years	57 (72.2%) n = 79	9 (50%) n = 18	48 (78.7%) n = 61	
4 years	32 (60.3%) n = 53	7 (50%) n = 14	25 (64.1%) n = 39	0.18
5 years	33 (75%) n = 44	6 (66.7%) n = 9	27 (77.1%) n = 35	
6 years	24 (68.6%) n = 35	4 (66.7%) n = 6	20 (69%) n = 29	

groups OPD vs PC, with the PC group showing a higher success rate after the 1-year time point (Figure 1). Statistical analysis was also carried out to investigate any differences in surgical success rates in esotropia and exotropia groups separately. The OPD group had 57 patients with esotropia and 35 with exotropia. In the PC group, these values were 95 and 57, respectively. There was no statistically significant difference in the esotropia to exotropia ratio between groups ($p = .9$). In esotropia surgery, PC patients had a higher success rate than OPD patients only at 3 years follow-up (81.8% vs 42.9%, respectively, $p = .001$), showing a similar pattern to the whole group. In exotropia surgery, there was no significant difference between groups (74% vs 71%, $p = .81$). Visit parameter comparisons in the esotropia patients showed a longer follow-up duration, and a smaller distance and near post-operative deviation angle in the PC group. Among exotropes, with the exception of a longer follow-up period in the PC group ($p = .03$), these differences were not seen.

DISCUSSION

Our study compared the success rates of strabismus surgeries performed in an OPD setting to those performed in a PC setting in the same academic institution. Patients whose surgeries were performed in PC had a significantly longer follow-up duration than those whose surgeries were done at the OPD (34.9 vs 25.3 months). The surgical success rate was similar between groups at short term follow-up: 6 months, 1 year and 2 years (Table 4). After 2 years, a significantly higher success rate in the PC group was observed, namely at 3, 5 and 6 years. Further analysis dividing the surgeries into esotropia and exotropia revealed a similar pattern in esotropia surgery at 3 years follow-up but not for exotropia surgery. The discrepancy in results between these two populations of patients is multifactorial. In both groups, measurements were double checked with an attending physician and finalized before surgery. The OPD patients may have presented later for follow-up and had less financial support for glasses, exposing the inequalities of healthcare access and quality of care between the two populations. In addition, there might be some differences in strabismus diagnoses between the two groups, leading to respectively different surgical outcomes since some strabismus entities are prone to recurrence by natural history. The surgeon factor (OPD patients were operated on by residents-in-training and PC patients by staff ophthalmologists) did not seem to contribute to the differential surgical outcome as a similar success rate was observed up to 2 years after which the gap widened; thus, incriminating other possible factors.

Previous literature has compared surgical outcomes according to socioeconomic status of patients across different medical specialties.[5] As for ophthalmology, countries with very low socioeconomic status had the highest proportions of poor ophthalmologic surgical outcomes and cataract blindness attributed to less available resources in such countries.[2] In strabismus surgery, a 20% rate of treatment non-compliance was observed in the failed cases.[19] Low socioeconomic status was associated with less utilization of eye care tools including eyeglasses.[20] It was also a predictive factor for low compliance with patch therapy, leading to worse outcomes.[21] In many academic medical institutions, outpatient departments are run primarily by residents as part of their training, and they are mainly visited by patients of lower socioeconomic status and without medical insurance.[3] This can possibly explain the comparable success rate at short term follow-up between groups as the same surgical technique was used in the same institution/operating room; but the difference in long-term outcome most likely was due to suboptimal follow-up and compliance with management plans in a group with limited resources.

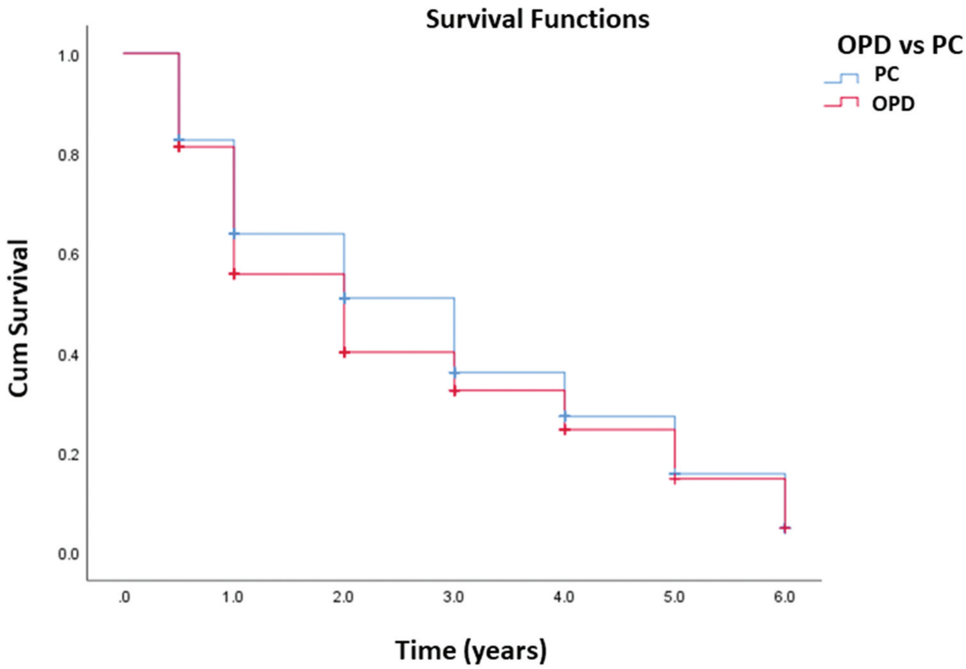

Figure 1. Kaplan–Meier survival curve: (success rate in % vs time in years) for outpatient department (OPD) and private clinic (PC) surgeries.

Surgeon factor certainly has a contributory role in this comparison, although did not seem to have a bearing on our results. Only a few previous studies have tackled success rates of strabismus surgeries performed by residents and those performed by attending ophthalmologists. A retrospective review looked at 315 horizontal strabismus surgeries performed by attending surgeons, and compared their success rates to 207 similar surgeries performed by resident physicians under the guidance of the attending surgeons.[14] After an average follow-up period of 57 weeks, no statistically significant difference was seen in success rate after adjusting for population differences (58% in the residents group vs 69% in the attendings group).[14] Similarly, another retrospective study revealed that after an average follow up period of 335 days, success rates were similar between trainees and surgeons (80% and 82%, respectively; $p = .59$).[13] This study however included both residents and fellows together as "trainees." More recently, a study reported that at 3 months, success rate of strabismus surgeries in children performed by attending surgeons was 72%, statistically similar to that done by residents (64%).[12] However, residents needed significantly more time than attending surgeons to complete eye muscle surgeries (35.5 minutes vs 19.3 minutes, respectively).[22]

Our success rates in the current cohort are very similar to the absolute numbers reported in the above studies. However, in contrast, we detected a significant difference in long-term success rates between PC patients (operated by staff surgeons) and OPD patients (operated by resident surgeons). Our follow-up period in the current study (34.9 months in the PC group and 25.3 months in the OPD group) was the longest compared to the above similar works (57 week, 335 days, and 3 months). The longer follow-up time seemed to uncover more statistically significant differences related to the long-term management; success rate in our own cohort did not differ between the groups at the 6-months and 1-year time points. We noticed a higher success rate in the PC group at longer follow-up periods (3, 5 and 6 years); explanations include amblyopia treatment, compliance with glasses and possible reoperation, rather than a true lower success rate in the hands of residents-in-training. Additionally, we have compared two distinct patient groups in our study: one being followed up in the OPD (by residents) and another being followed in a PC setting. In previous literature, the patient population mostly belonged to only one clinical setting, and the choice of surgeon (resident vs attending) would be made at the discretion of the staff surgeon. In our center, a separate outpatient clinic is devoted to residents, where patients are followed by residents peri-operatively, under direct supervision of staff ophthalmologists. Some of our findings that proved different from other similar studies may have emanated from this difference in the setting where compliance with post-operative management in the PC setting was more rigorous. In our OPD group, possible factors decreasing the surgical success rate could be less compliance with treatment (glasses/patching) and missing post-operative follow-up appointments. One study looked at the correlation between the time in advance an appointment is scheduled and the no-show rate, in both types of clinics.[23] The average no-show rate was 9.1% and 2.4% for the resident- and faculty-clinic, respectively.[23] Dembinski et al. reported that cases of strabismus surgery failure were 20% more in patients non-compliant with their treatment plan.[19] That may be one explanation for our shorter follow-up time for the resident-performed strabismus surgeries. Nonetheless, staff surgeons always supervised the entire procedure in our center and took meticulous pre-operative measurements with the resident.

Furthermore, we divided horizontal strabismus surgery into subtypes (esotropia vs exotropia). In our cohort, esotropia surgery could have been more challenging (with a lower success rate in the resident-performed surgeries) possibly due to a smaller surgical field in the nasal orbit. In contrast, in a previous study, success rate of strabismus surgery was lower when performed by residents-in-training on exotropic eyes, attributed to the use of adjustable sutures, a younger patient age and more amblyopia.[14] Additionally, OPD patients had other ET diagnoses including sensory ET, CN VI palsy and Duane which tend to have higher postoperative recurrence rates with time and require further surgery. It is known that certain subtypes of strabismus have a higher success rate after surgical correction; one example is accommodative esotropia as compared to the congenital type. The success rate of accommodative esotropia surgery was reported at 86.4% in a study by Kushner.[24] The existing literature reports a surgical success range for infantile esotropia between 83% and 94% in patients undergoing early surgery (by 6 months of age),[25] and the value goes down to reach as low as 23% in patients with a large angle of deviation (≥55 PD).[26,27] Congenital esotropia patients have up to 34% need for reoperation,[28] with a large angle of deviation (above 30 PD) being a risk factor.[28]

Our study results may be of benefit to residency training programs and serve as a useful tool for regulatory bodies namely the ACGME (Accreditation Council for Graduate Medical Education), especially for programs where residents follow surgical patients in a separate outpatient department, different from a private clinic practice.[29] Providing more support for patients in a resident clinic in terms of appointment follow-up and resources for glasses/other therapies could improve long-term outcomes. Limitations of this study include its retrospective nature with possible missing charts/visit data, especially sensory outcomes for OPD patients (seen by residents). Our surgical outcomes mostly reflected motor success, as sensory outcomes were missing for many patients. Several subjects were lost to follow-up mostly in the OPD. Final follow-up time was longer for PC patients than for OPD patients. Sub-analysis into strabismus subtypes was limited by the smaller sample size for statistical comparison.

CONCLUSION

In conclusion, success rate of strabismus surgery was similar between PC patients (operated on by staff surgeons) and OPD patients (seen and operated on by training ophthalmology residents) in the same institution at 6 months and 1 year follow-up but differed at long term follow-up after 2 years showing higher success rate in a private clinic setting. The same pattern was seen in the esotropia subtype at 3 years follow-up, but not for exotropia patients. The reasons are multifactorial including differences in socioeconomic status of patients in the 2 types of clinics translating to differences in compliance with follow-up and long-term management plans and access to resources, as well as possible discrepancies in baseline strabismus subtypes rather than the surgeon factor.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author, C. A, upon reasonable request

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