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Effect of Trichiasis Surgery on Visual Acuity Outcomes in Ethiopia

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Abstract

Objectives—To determine the effect of trichiasis surgery on visual acuity.

Methods—A total of 439 participants in the Surgery for Trichiasis, Antibiotics to Prevent Recurrence (STAR) trial had visual and subjective concerns measured before and 6 months after surgery. Trichiasis surgery was performed in at least 1 eye by integrated eye care workers. Visual acuity was measured using illiterate E versions of Early Treatment Diabetic Retinopathy Study charts with standardized, forced-choice procedures. Improvement was defined as improvement in visual acuity greater than 1 line (5 letters).

Results—The mean improvement in visual acuity for the eyes that had surgery was 0.129 logMAR units ($P < .001$). Surgery was associated with improvement in visual acuity compared with no surgery (odds ratio, 1.68; 95% confidence interval, 1.04–2.70). Independent predictors of visual acuity improvement in the eyes that had surgery included the number of lashes touching the globe prior to surgery and baseline visual acuity. Among patients, 93.8% described significant pain and 90.4% significant photophobia at baseline compared with only 1.4% and 0.9%, respectively, following surgery.

Conclusions—Surgery to correct trichiasis appears to provide significant visual acuity improvement as well as a decrease in subjective concerns in patients with trachomatous trichiasis.

Trial Registration—clinicaltrials.gov Identifier: NCT00347776

Trachoma is the leading infectious cause of blindness worldwide.¹ This chronic conjunctivitis is caused by infection with the bacterium *Chlamydia trachomatis*. Years of repeated episodes of trachoma causes scarring of the eyelid, which may result in inward turning of the eyelashes, a painful, debilitating condition known as trachomatous trichiasis.² The in-turned, or trichiatic, eyelashes scratch the surface of the eye and the cornea, which can result in corneal scarring and eventual blindness.² The World Health Organization

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(WHO) estimates that that trachoma accounts for 3.6% of global blindness³; if 3.6% of visual impairment globally is due to trachoma, then an estimated 5.8 million people are visually impaired by it. In trachoma-hyperendemic regions of countries such as Ethiopia, the prevalence of trichomatous trichiasis in adults has been reported to be as high as 7%.^{4,5}

Surgery for trichiasis is an important component of the WHO's strategy to eliminate blinding trachoma by the year 2020, which consists of surgery for trichiasis, antibiotic use, facial cleanliness, and environmental improvement (SAFE).⁵ In particular, the WHO recommends bilamellar tarsal rotation, as this procedure has been reported to have the highest success rates compared with cryoablation and tarsal advance and rotation.^{6,7} Surgery is performed to correct trichiatic eyelids, and would be expected to improve pain and photophobia associated with trichiasis, but the effect on visual acuity deficit is unclear. Three studies have reported conflicting relationships between trichiasis surgery and change in visual acuity. Studies in Oman and The Gambia found an improvement in visual acuity following surgery,^{6,8} while a small study found no relationship.^{9,10}

Thus, some evidence exists regarding improvement in visual acuity following trichiasis surgery, although the magnitude of that improvement is unclear. The objective of this study was to determine the association between trichiasis surgery and changes in visual acuity outcomes in the context of a clinical trial of patients having trichiasis surgery in Ethiopia.

METHODS

This study uses data from the Surgery for Trichiasis, Antibiotics to Prevent Recurrence (STAR) trial, a randomized, single-masked, clinical trial of 1452 patients who had trichiasis surgery in the Wolayta Soddo Zone of southern Ethiopia.^{11,12} The primary aim was to determine whether postoperative treatment with oral azithromycin reduces trichiasis recurrence rates 1 year after surgery compared with topical tetracycline. The methods of data collection for the trial have been described in detail previously.¹¹ In brief, patients aged 18 years and older with trichiasis in at least 1 eye not treated surgically were eligible for enrollment. All patients had bilamellar tarsal rotation surgery performed by local integrated eye care workers who were trained immediately prior to the study and certified especially for this trial. Participants were randomly assigned to receive 6 weeks of topical tetracycline twice daily or a single 1-g dose of azithromycin postoperatively.

Throughout the trial, visual acuity measurements were taken at baseline. For the final phase of enrollment (October-December 2003), all 439 participants were also asked to have their visual acuity measured 6 months after surgery. These participants are the cohort used for the present analysis.

MEASUREMENT OF VISUAL ACUITY

Presenting distance visual acuity for each eye was measured using a commercially available logMAR tumbling E chart. Measurements were performed with the chart fully illuminated by the sun. Visual acuity was determined at 3 m, with the participants' presenting refracting correction. Forced choice procedures following strict protocols were done, and the number of letters read was recorded. Examiners stopped when the participant could not read 3 of 5

letters on a line correctly. If the participant was unable to correctly identify 3 of the 5 letters on the first line, visual acuity was tested at 1 m. If the patient was unable to read the first line of the chart at 1 m, hand motion, light perception (LP), and no light perception (NLP) were assessed at 1 m. Counting fingers assessment was not done. Acuity was only assessed to the 20/20 line.

TRICHIASIS

Trichiasis was defined according to WHO criteria as the presence of 1 or more lashes touching the globe and/or evidence of epilation.¹³ The number of lashes touching any part of the globe and the number touching the cornea, in particular, were recorded. If more than 10 lashes were found to be touching the globe, the numeral 10 was recorded. Evidence of epilation, defined as the visible presence of eyelash stubs, was noted as present or absent. Entropion was graded as mild (all lash bases visible), moderate (some lash bases visible but others not), or severe (all lash bases not visible). Eyes that did not have surgery did not have trichiasis.

SUBJECTIVE ASSESSMENTS OF VISION

Participants' subjective assessment of their vision was evaluated through inquiry regarding the amount of pain and photophobia they experienced. Pain was rated on a scale from 1 to 4, with 1 indicating no pain; 2, some pain; 3, moderate pain; and 4, severe pain. Photophobia was based on a question about the difficulty they had seeing in bright sunlight, which was rated on a scale from 1 to 4, with 1 indicating no difficulty, 2, some difficulty, 3, moderate difficulty, and 4, severe difficulty. These assessments were available for the baseline and 6-month follow-up visits for this cohort.

STATISTICAL ANALYSIS

Data analyses were performed using Stata version 9.0 (Stata-Corp LP, College Station, Texas). Visual acuity was scored as the number of letters read and then converted to logMAR scores. Significant eye pain was defined as moderate severe pain, while significant photophobia was defined as moderate or severe difficulty seeing in bright light. Bivariate relationships were explored using simple linear regression to examine differences in baseline visual acuity and subjective complaints by sex, age category, and number of lashes touching the globe (severity of trichiasis) in all eyes.

Changes in visual acuity between baseline and 6 months after surgery were assessed using paired 2-sided *t* tests. The eyes in which no surgery was performed (eyes without trichiasis, *n*=88) served as a comparison group for the eyes in which surgery was performed (*n*=790). The analysis was performed excluding eyes with a baseline visual acuity of LP or NLP (*n*=35) for 2 reasons: (1) they would not have to have arbitrary logMAR scores assigned, which might skew results, and (2) they were blind largely from causes such as retinal degeneration or severe cataract, which would not be expected to improve owing to trichiasis surgery. We did not exclude corneal opacities. Seven eyes did not have visual acuity recorded at baseline, and 18 eyes did not have visual acuity measures at follow-up. We defined improvement in visual acuity as an improvement of more than 1 line (0.1 logMAR) of visual acuity. Using all remaining eyes (*n*=818), a multivariable logistic regression model

was used to determine whether surgery, controlling for other factors, was associated with an improvement in visual acuity. The standard error of the estimates obtained from all regression modeling were corrected using the generalized estimating equation approach to adjust for the correlation between eyes. Individuals' subjective assessments of vision, namely pain in eyes and difficulty seeing in bright light at baseline vs 6 months after surgery, were compared using McNemar's χ^2 test.

All procedures and protocols for this study were reviewed and approved by the Johns Hopkins Institutional Review Board and the Ethiopian Science and Technology Commission.

RESULTS

BASELINE CHARACTERISTICS

Of the 1452 participants enrolled in the STAR trial, 448 patients were recruited in the last enrollment period, 439 (98.0%) of whom were available 6 months after surgery. Nine (2.0%) individuals were not followed up at 6 months, 6 of whom had developed recurrent trichiasis before the 6-month follow-up, 2 who died, and 1 who moved away prior to the 6-month visit. The 439 participants were mostly female (74%), as was true for the whole population (Table 1). A total of 351 patients (80%) had surgery on both eyelids, while 88 had surgery on 1 eyelid only, resulting in 790 eyelids that had surgery and 88 eyelids that did not. Most (94%) patients described moderate to severe pain in their eyes at baseline, and 90% reported that it was difficult or very difficult to see in bright sunlight.

Baseline characteristics of the eyes stratified by whether they had surgery are shown in Table 2. For the eyes that had surgery, the mean baseline visual acuity was 20/120 (logMAR, 0.78) and the median value was 20/75 (logMAR, 0.57). Only 20% of eyes had a baseline visual acuity of 20/40 or better, and none had 20/20, while 21% had a visual acuity worse than 20/400 and 4.5% had LP or NLP. Most eyes (79%) had evidence of epilation. Signs of severe trichiasis were common, with 16% having severe entropion; 39%, 5 or more lashes touching the globe; and 30%, 5 or more lashes touching the cornea.

Differences by age, sex, and baseline severity were examined for the outcomes of visual acuity and subjective symptoms (Table 3 and Table 4). There were no differences by sex, but with increasing age category, a higher mean logMAR value was observed; the mean logMAR score was 0.626 for participants aged 40 years or younger, 0.778 for participants aged between 41 and 59 years ($P=.006$), and 0.954 for individuals 60 years old or older ($P<.001$). A greater number of lashes touching the globe was associated with an increase in the mean logMAR score. Severe trichiasis was associated with subjective eye pain and photophobia.

Paired baseline and follow-up visual acuity measurements were available for 739 eyes that had surgery and 79 that did not after excluding 35 eyes with visual acuity of LP or NLP at baseline and 25 eyes in which visual acuity data were missing at either baseline or follow-up (Table 5). The mean improvement in visual acuity for the eyes that had surgery was 0.129 logMAR units. A smaller, yet statistically significant, mean improvement in visual acuity of

0.079 logMAR units was observed in the eyes that did not have surgery. Only 36 eyes (4.6%) had experienced recurrence between 2 and 6 months after surgery, too few to examine the effect of recurrence.

To examine the effect of surgery, a multivariate model using all eyes was developed to predict improvement in visual acuity of greater than 1 line ($\log\text{MAR} > 0.1$), adjusting for age and sex (Table 6). Surgery provided a significant improvement in visual acuity (OR, 1.68; 95% CI, 1.04–2.70). Postoperative treatment with azithromycin compared with tetracycline was not associated with significant visual acuity improvement.

We further explored the factors related to visual acuity improvement in the eyes that had surgery, which would allow us to include severity of trichiasis (eyes that did not have surgery did not have trichiasis). The only predictor of eyes that would improve was number of lashes touching the globe, with those with more severe trichiasis most likely to have improvement (OR, 2.02; 95% CI, 1.30–3.13) (Table 7). Because severe trichiasis was associated with worse baseline vision, we could not model the 2 predictors together. However, if we substitute baseline visual acuity for baseline trichiasis severity, a similar statistically significant association was observed (data not shown).

We could not examine the effect of recurrence on visual acuity because we only had 30 eyes with recurrent trichiasis at 6 months in this cohort. While the visual acuity at follow-up was worse in these eyes than in eyes with nonrecurrent symptoms (0.959 vs 0.771 logMAR units, respectively), the difference in outcome was not significant ($P = .08$).

SUBJECTIVE ASSESSMENTS

Trichiasis surgery improved subjective assessments of pain and photophobia. At baseline, most individuals (93.8%) described their pain as moderate/severe, while 6 months after surgery, only 1.4% described this level of pain intensity ($P < .001$) (Table 8). Similarly, while 90.4% of patients reported seeing in bright sunlight as difficult or very difficult at baseline, only 0.9% found it to be significantly difficult after surgery ($P < .001$). We were not able to evaluate the possibility that acuity improvements were due to improvement in the subjective symptoms, as so few people had problems after surgery.

COMMENT

In this study, we found that surgery for eyes with trichiasis provided significant improvement in visual acuity at 6 months compared with eyes without trichiasis that did not have surgery. On average, eyes that had surgery improved 1 to 2 lines of visual acuity. Eyes with severe trichiasis at baseline were most likely to show improvement in vision. Trichiasis surgery also appeared to result in a major decline in significant eye pain and photophobia.

The results of this study are consistent with earlier studies conducted in Oman and The Gambia that described improvement following surgery. In Oman, a beneficial effect of surgery was described for visual acuity of eyes with major trichiasis at 9 or 21 months compared with fellow eyes that did not have surgery.⁶ On average, visual acuity improved by half a line of Snellen acuity.⁶ As in our study, the use of eyes that did not have surgery as

a comparison group makes the improvement in visual acuity in the present study unlikely to be due solely to any learning effect of repeated visual acuity testing. The Gambian study also demonstrated visual acuity improvement 12 months after surgery but did not use a comparison group of eyes that did not have surgery.¹⁰ The magnitude of visual acuity improvement seen was 0.14 logMAR units, which represents 1 to 2 lines of visual acuity improvement and is similar to the improvement of 0.13 logMAR units that we found among surgical eyes in our study.

Other studies have shown no significant change in or deterioration of visual acuity with trichiasis surgery.^{8,9} One study in The Gambia found no change in visual acuity at 1 year,⁸ based on visual acuity in the better-seeing eye (which may not have been the eye receiving surgery). We found that improvement was more likely with more severe trichiasis at baseline and worse in the surgical eye at baseline. Use of the better eye for the analysis in The Gambian study is one possible reason why no acuity benefit was observed if surgery was performed on the eye with worse sight. Another study reported deterioration in vision 3 to 4 years after surgery.⁹ This finding likely indicates that time elapsed since surgery may be an important determinant of the change in visual acuity observed if recurrence is high (42% in this study) and if the population is older and subject to vision loss due to cataract. The high rates of trichiasis recurrence also distinguish these studies from ours, which had a low incidence of trichiasis recurrence following surgery (4.6%). This is important because in The Gambia, less improvement was seen in eyes with recurrent trichiasis compared with those without recurrent trichiasis.⁹ In our study, a similar trend was observed, but with only 36 of the 790 eyes that had surgery developing recurrent trichiasis, the power of the study to detect change for recurrent eyes was limited.

There are several possible reasons why trichiasis surgery may lead to improvement in visual acuity. One is that surgery to correct trichiasis results in decreased corneal edema and ocular discharge, with some restoration of the corneal surface after removal of the trichiasis lashes. This is supported by a study that showed that surgical correction of trichiasis resulted in a significant reduction in the prevalence of corneal opacity.⁹ Another possibility is that trichiasis surgery leads to a significant improvement in individuals' subjective symptoms and thus increases their ability to perform visual acuity testing. Indeed, we found that trichiasis surgery resulted in a substantial decrease in the amount of significant eye pain and photophobia. However, we were unable to ascertain if the improvement in visual acuity occurred as a result of the decrease in subjective concerns, as only a very small number of participants (less than 1.5%) reported significant problems after surgery.

Our data indicate that worse baseline trichiasis severity or worse baseline visual acuity were significant predictors of visual acuity improvement after surgery, a finding similar to that in The Gambia.¹⁰ Other series of patients with mostly modest trichiasis or modest acuity loss at baseline may not find such significant improvement in vision. For our analyses, we excluded eyes with LP or NLP, as they would be more likely to have vision loss from other causes and not result in improvement with trichiasis surgery. These eyes only made up 3.5% of the eyes in our cohort, but if they are more frequent in other patient mixes, the change in visual acuity will be more modest.

One limitation of our study is the relatively short time after surgery in which we remeasured visual acuity, ie, 6 months. However, we wanted to measure an effect of surgery, and the longer the time of follow-up since surgery, the more likely other causes are to influence the findings such as recurrence or progression of cataract. Also, a shorter time period minimizes loss to follow-up. However, additional follow-up times at 12 months or later would have been desirable to determine if the beneficial effect of surgery persisted.

Finally, this is a secondary analysis in the context of a clinical trial, and while we explored biologically relevant factors prespecified before the analyses, we are aware of these limitations.

In summary, trichiasis surgery was found to have improved visual acuity outcomes at 6 months in this cohort of Ethiopian patients, with eyes that had surgery being 1.7-fold more likely to experience significant improvement in visual acuity than eyes that did not have surgery. In addition, the surgery resulted in a substantial reduction in subjective concerns of significant eye pain and photophobia. Thus, surgery appears valuable, not only to prevent vision loss, but to recover some vision in patients with trichiasis.

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Table 1

Characteristics of 439 Trial Participants

Characteristic	No. (%)
Mean (SD) age, y	48.5 (13.5)
Female	326 (74.3)
Surgery performed ^a	
Right eye only	32 (7.3)
Left eye only	56 (12.8)
Both eyes	351 (80.0)
Previous surgery	
No	429 (97.7)
Yes	10 (2.3)
Treatment group	
Azithromycin	292 (66.5)
Tetracycline	147 (33.5)
Subjective assessment of vision	
Pain in eyes ^b	
No pain	0 (0)
Some pain	26 (6.2)
Moderate pain	21 (5.0)
Severe pain	373 (88.8)
Sight in bright sunlight ^c	
No difficulty	4 (1.0)
Some difficulty	36 (8.6)
Moderate difficulty	350 (83.3)
Severe difficulty	28 (6.7)

^a A total of 790 eyelids had surgery, while 88 did not.

^b Data missing for 19 individuals.

^c Data missing for 21 individuals.

Table 2

Baseline Characteristics of 790 Eyes That Had Surgery and 88 Fellow Eyes That Did Not

Characteristic	No. (%)	
	Surgery (n=790)	No Surgery (n=88)
Mean (SD) logMAR ^a	0.778 (0.576)	0.720 (0.619)
Mean visual acuity	20/120	20/105
Median logMAR	0.574	0.477
Median visual acuity	20/75	20/60
Visual acuity ^a		
20/40 or better	159 (20.3)	26 (29.6)
<20/40–20/60	181 (23.2)	20 (22.7)
<20/60–<20/200	236 (30.2)	21 (23.9)
20/200–20/400	44 (5.6)	3 (3.4)
<20/400–200/800	46 (5.9)	4 (4.6)
HM	89 (11.4)	6 (6.8)
LP or NLP	27 (3.5)	8 (9.1)
Evidence of epilation		NA
No	164 (20.8)	
Yes	626 (79.2)	
Entropion		NA
Mild	451 (57.1)	
Moderate	215 (27.2)	
Severe	124 (15.7)	
No. of lashes touching the globe		NA
None (epilate all)	218 (27.6)	
1–4	262 (33.2)	
5–9	159 (20.1)	
10	151 (19.1)	
No. of lashes touching the cornea		NA
None (epilate all)	218 (27.6)	
0	30 (3.8)	
1–4	309 (39.1)	
5–9	121 (15.3)	
10	112 (14.2)	

Abbreviations: HM, hand motion; LP, light perception only; NA, not applicable; NLP, no light perception.

^aEight eyes that had surgery were missing values.

Table 3Baseline Visual Acuity by Sex, Age, and Trichiasis Severity^a

Characteristic	No.	Mean LogMAR	P Value ^c
Sex			
Male	222	0.737	
Female	648	0.785	.39
Age, y			
40	310	0.626	
41–59	320	0.778	.006
60	240	0.954	<.001
No. of lashes touching the globe			
None (do not epilate) ^b	88	0.720	
None (epilate all)	217	0.727	.07
1–4	258	0.639	>.99
5–9	157	0.713	.14
10	150	1.16	<.001

^aN = 870 eyes; for 8 eyes, baseline visual acuity values were unavailable.

^bEyes without trichiasis (no surgery).

^cP value of difference; correlation between left and right eyes accounted for using generalized estimating equation.

Table 4

Subjective Concerns by Sex, Age, and Trichiasis Severity

	No.	OR (95% CI)	
		Significant Pain in Eyes ^a	Significant Photobia ^b
Sex			
Male	113	1 [Reference]	
Female	226	2.21 (0.98–4.99)	1.24 (0.61–2.54)
Age, y			
40	155	1 [Reference]	
41–59	161	0.66 (0.26–1.66)	0.70 (0.33–1.49)
60	123	1.00 (0.34–2.97)	1.08 (0.44–2.63)
No. of lashes touching the globe			
None (epilate all)	85	3.32 (0.92–11.91)	2.27 (0.87–5.93)
1–4	136	1 [Reference]	1 [Reference]
5–9	102	2.28 (0.79–6.57)	1.92 (0.80–4.59)
10	116	3.25 (1.04–10.20)	2.56 (1.04–6.36)

Abbreviations: CI, confidence interval; OR, odds ratio.

^aFor the number of lashes touching the globe, the most severely affected eye of an individual was used in the analysis.^bN = 439 individuals.

Table 5Change in Visual Acuity Between Baseline and 6 Months of Eyes That Had Surgery vs Those That Did Not^a

	Surgery (n=739)		No Surgery (n=79)	
	Baseline	6 mo	Baseline	6 mo
Median logMAR	0.512	0.477	0.439	0.398
Mean (SD) logMAR	0.738 (0.544)	0.609 (0.488)	0.604 (0.511)	0.524 (0.493)
Mean (SD) difference in logMAR	-0.129 (0.302)		-0.079 (0.206)	
95% CI	-0.151 to -0.107		-0.125 to -0.033	

Abbreviation: CI, confidence interval.

^aExcluding 60 eyes with baseline visual acuity of light perception or no light perception, or without visual acuity values recorded.

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Table 6

Multivariate Model of Factors Predicting Visual Acuity Improvement of Greater Than 1 Line (>0.1 LogMAR) Using All Eyes^a

Characteristic	No.	OR (95% CI)
Age, y		1.00 (0.99–1.01)
Female	614	1.06 (0.74–1.52)
Surgery	739	1.68 (1.04–2.70)
Treatment with azithromycin ^b	543	0.74 (0.53–1.02)

Abbreviations: CI, confidence interval; OR, odds ratio.

^aExcluding 60 eyes with baseline visual acuity of light perception or no light perception, or without visual acuity values; n = 818 eyes.

^bCompared with tetracycline.

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Table 7

Multivariate Model of Factors Predicting Visual Acuity Improvement of Greater Than 1 Line (>0.1 LogMAR) Among Eyes That Had Surgery^a

Characteristic	No.	OR (95% CI)
Age, y		1.00 (0.99–1.01)
Female	560	1.01 (0.69–1.47)
No. of lashes touching the globe		
None (epilate all)	211	1.13 (0.77–1.66)
1–4	244	1 [Reference]
5–9	150	1.34 (0.89–2.02)
10	134	2.02 (1.30–3.13)
Trichiasis recurrence	29	0.59 (0.27–1.29)

Abbreviations: CI, confidence interval; OR, odds ratio.

^aExcluding 51 eyes with visual acuities of light perception or no light perception, or without visual acuity values; n = 739.

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Table 8

Subjective Assessments of Visual Outcomes at Baseline and 6 Months for 439 Trial Participants

Visual Outcome	No. (%)		P Value
	Baseline	6 mo	
Pain in eyes ^a			
No pain	0 (0)	408 (94.9)	<.001
Some pain	26 (6.2)	16 (3.7)	.10
Moderate pain	21 (5.0)	3 (0.7)	<.001
Severe pain	373 (88.8)	3 (0.7)	<.001
Sight in bright sunlight ^b			
No difficulty	4 (1.0)	299 (69.5)	<.001
Some difficulty	36 (8.6)	127 (29.5)	<.001
Moderate difficulty	350 (83.3)	4 (0.9)	<.001
Severe difficulty	28 (6.7)	0 (0)	<.001

^aData missing for 19 individuals at baseline.^bData missing for 21 individuals at baseline.