The Clinical Phenotype of Trachomatous Trichiasis in Ethiopia: Not All Trichiasis Is Due to Entropion

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Purpose. Trachomatous trichiasis (TT) is usually described as a cicatricial entropion of the upper lid; however, other forms of trichiasis have been reported. This variation in clinical phenotype is potentially important for treatment guidelines. Therefore, this study was conducted to investigate the range of disease type and severity encompassed by TT.

Methods. Individuals presenting with TT to surgical treatment campaigns were examined by a single ophthalmologist using the Detailed WHO Trachoma Grading System. Additional features were graded, including type of trichiatic lashes (metaplastic, misdirected, and entropic), lower lid trichiasis, entropion severity, and lid margin mucocutaneous junction (MCJ) position.

Results. Recruited were 2556 individuals with previously unoperated TT in at least one eye (4310 eyes). The median number of lashes touching the eye was 2 (range, 0 [epilating]–133). Entropion was absent or mild in 2328 (54.0%) eyes, moderate in 1259 (29.2%) eyes, and severe in 723 (16.8%) eyes. Trichiatic lashes were predominantly metaplastic or misdirected (80.2%), rather than secondary to entropion; 4204 (97.7%) had anteroplacement of the MCJ; and lower lid trichiasis was present in 494 (11.5%). Entropion was more severe among those with a low BMI, those who were female, those aged less than 50 years, and those with moderate to severe conjunctival inflammation, central corneal opacity, and severe conjunctival scarring.

Conclusions. Many patients with TT have minimal or no entropion. The trichiasis is frequently attributable to metaplastic or misdirected eyelashes. The results of tarsal rotation surgery in TT patients without manifest entropion should be investigated and potentially alternative treatment strategies evaluated. (*Invest Ophthalmol Vis Sci.* 2011;52:7974–7980) DOI:10.1167/iovs.11-7880

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Trachoma is a lifelong disease. It starts in childhood with recurrent *Chlamydia trachomatis* infections and persistent conjunctival inflammation. With time, scarring develops that can cause cicatricial entropion, trichiasis, and eventually blinding corneal opacification. Trichiasis is often accompanied by marked pain, photophobia, and epiphora.[1] Trachoma is endemic in more than 50 countries, primarily in Africa and Asia. The most recent published estimates indicate that approximately 8 million individuals have trachomatous trichiasis (TT).[2] Ethiopia has one of the highest prevalences of active trachoma in children and the most TT cases (1.3 million).[2] The disease is the second commonest cause of blindness and low vision in the country.[3]

In most endemic countries, trachoma control programs implement the SAFE strategy: surgery for trichiasis, antibiotic treatment for chlamydial infection, facial cleanliness, and environmental improvements. Current World Health Organization (WHO) guidelines recommend tarsal rotation surgery for all cases of TT, irrespective of trichiasis severity, and the degree of entropion.[4] The rationale for this is that trichiasis is the major risk factor for the development of corneal opacification (CO), and it is argued that patients living in remote rural locations may only rarely have the opportunity to receive treatment. Therefore, deferral of treatment until more severe disease develops may result in some individuals loosing vision. However, studies with a year or more follow-up show postsurgical TT recurrence rates ranging from 7% to 62%.[5–14] Furthermore, in some societies, there is often great reluctance among patients to accept surgery, for various reasons including cost, fear, transport difficulties, limited time, and awareness that results are sometimes poor.[15–21]

TT is a spectrum of disease. At one extreme, the whole eyelid (usually the upper) is entropic with all the eyelashes touching the eye (Fig. 1a). This is the phenotype that is generally described in the literature in relation to this disease. Undoubtedly, such patients require urgent treatment to correct their entropion, which in most trachoma-endemic countries is usually either the bilamellar tarsal rotation (BLTR) or the posterior lamellar tarsal rotation (PLTR) procedure.[5,6,22] At the other extreme, there may be no manifest entropion and only one lash touching the eye. This may arise either from misdirected (lash arises from the normal lash line but deviates abnormally; Fig. 1b) or metaplastic eyelashes (lash arises from an abnormal posterior location; Fig. 1c). The optimal treatment for these milder forms of TT without entropion is uncertain. The use of a tarsal rotation procedure in such cases may not be the most appropriate intervention, but this notion has received relatively little attention in the literature, in part because there

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FIGURE 1. Clinical features of TT. (**a**) Entropic trachomatous trichiasis. (**b**) Misdirected lash. (**c**) Metaplastic lash. (**d**) Plica effacement in trachomatous trichiasis. (**e**) Lower lid symblepharon in trachomatous trichiasis. (**f**) Upper lid symblepharon in trachomatous trichiasis.

are few detailed reports documenting the range and prevalence of the various phenotypes in endemic populations. One case series from a specialist oculoplastic clinic in Oman reported the presence of lash abnormalities in addition to trachomatous trichiasis.[23] Two studies from Ethiopia have reported the variable degree of entropion associated with TT, which can vary from none to complete.[24,25] However, these two components, the degree of entropion and aberrant lashes, as well as other clinical signs, have not been described in detail together in a large series of patients. This deficit in the literature has potentially significant implications for managing this condition. Therefore, we conducted a cross-sectional study to characterize the range and prevalence of clinical phenotypes encompassed by TT. In addition, we conducted a smaller, nested case–control comparison of specific clinical features, to investigate their frequency in TT cases relative to individuals without TT (normal controls) drawn from the same population.

METHODS

Ethical Approval

The study was approved by the National Health Research Ethics Review Committee of the Ethiopian Ministry of Science and Technology, the London School of Hygiene and Tropical Medicine Ethics Committee, and the Emory University Institutional Review Board. Informed consent for the study was obtained at enrollment. This research adhered to the tenets of The Declaration of Helsinki.

Trichiasis Cases

Individuals with previously unoperated trachomatous trichiasis were identified through a series of 17 surgical outreach campaigns in six districts (woredas) in Amhara National Regional State, Ethiopia. Trachomatous trichiasis was defined as one or more lashes touching the eye or clear evidence of epilation (broken/regrowing lashes) without another obvious cause for the trichiasis, such as trauma, malignancy, involutional changes, or severe blepharitis. The campaigns were advertised in local markets, churches, and schools. In addition, health extension workers, who are present in every subdistrict (kebele) in Ethiopia, were trained to recognize trichiasis and visited each village in their kebele to look for patients. All eligible patients who presented to the outreach campaigns with unoperated TT were recruited. Individuals were excluded from the study if they were pregnant (self reported), if the trichiasis had been previously operated on in both eyes (i.e., was recurrent), of if they were less than 18 years of age.

Normal Controls

For the purpose of the nested case–control component of this study, one randomly selected eye of all participants with major TT (>5 trichiatic lashes) living in prespecified geographic areas were included as cases. Normal controls (NC) without trichiasis, marked conjunctival scarring, or marked papillary inflammation in at least one eye were recruited, and were frequency matched for location, age (±10 years), and sex. If only one eye of the control had no trachomatous features, this eye was used for the case control study. If both eyes of a control did not have trachomatous features, one eye was chosen at random as the study eye.

Clinical Assessment

A field worker administered a questionnaire in Amharic. Height and weight were measured. Unaided (no patients had spectacles for distance correction), and pinhole logMAR visual acuities were measured at 4m, using an ETDRS equivalent tumbling-E logMAR chart (Hong

Kong Low Vision Centre). Examinations were conducted in a darkened room by a single ophthalmologist (SNR) using 2.5× magnification loupes and a bright torch. The number of trichiatic lashes was counted and subdivided according to where the lashes touched the eye in the primary position of gaze (cornea, lateral/medial conjunctiva). The type of trichiasis was also recorded: (1) entropic (lashes arise from normal lash line and follow normal lash direction, but an entropic lid position rotates the lashes, causing contact with the globe; Fig. 1a); (2) misdirected (lash follicles are in the normal lash line, but lashes point in an abnormal direction to touch the globe; Fig. 1b); (3) metaplastic (lashes emerge from aberrantly located follicles; Fig. 1c); and (4) mixed (more than one type of trichiasis). It should be noted that in the presence of entropion, lashes were categorized as entropic only if there was sufficient lid rotation to angle the lashes toward the globe. Lower lid trichiasis was recorded as present or absent. Clinical evidence of epilation was identified by the presence of broken or newly growing

Table 1. Demographic and Clinical Characteristics Study Participants

Characteristic	All Trichiasis Cases	Case–Control Study Participants	
		Trichiasis Cases	Normal Controls
Sex (female)	1845 (72)	294 (75.2)	294 (75.2)
Age, y			
<40	90 (23.3)	109 (27.9)	147 (37.1)
40–49	102 (26.4)	108 (27.6)	88 (22.5)
50–59	94 (24.4)	97 (24.8)	88 (22.5)
≥60	100 (25.9)	77 (19.7)	70 (17.9)
Mean (95% CI)*	49.9 (49.4–50.5)	49.6 (48.2–51.0)	47.9 (46.5–49.3)
Illiterate	2368 (98)	375 (95.9)	335 (85.7)
BMI, mean (95% CI)†	20.0 (19.9–20.1)	19.7 (19.5–19.9)	20.5 (20.1–20.7)
Entropion grade			
0	1016 (23.6)	36 (9.2)	387 (99.0)
1	1312 (30.4)	94 (24.0)	4 (1.0)
2	1259 (29.2)	151 (38.6)	—
3	416 (9.7)	63 (16.1)	—
4	307 (7.1)	47 (12.0)	—
Trichiasis (number of lashes)			
None		—	391 (100)
None-epilating	738 (17.1)	61 (15.6)	—
1–4	2495 (57.9)	129 (33.0)	—
5–9	542 (12.6)	117 (29.9)	—
10–19	335 (7.8)	45 (11.5)	—
20+	200 (4.6)	39 (10.0)	—
Lash type			
None (epilation)	738 (17.1)	61 (15.6)	391 (100)
Metaplastic only	1709 (39.6)	123 (31.5)	—
Misdirected only	710 (16.5)	55 (14.1)	—
Metaplastic and misdirected	447 (10.4)	48 (12.3)	—
Entropic with/without aberrant lashes	706 (16.4)	104 (26.6)	—
Lower lid TT			
Present	494 (11.5)	56 (14.4)	4 (1.0)
Papillary inflammation‡			
None (P0)	351 (8.2)	27 (6.9)	245 (62.7)
Mild (P1)	1415 (32.9)	121 (30.9)	139 (35.6)
Moderate (P2)	1987 (46.1)	179 (45.8)	7 (1.8)
Severe (P3)	553 (12.8)	64 (16.4)	0 (0.0)
Conjunctival scarring‡			
None (C0)	11 (0.3)	1 (0.3)	105 26.9
Mild (C1)	216 (5.0)	10 (2.6)	228 58.3
Moderate (C2)	3074 (71.4)	244 (62.4)	58 14.8
Severe (C3)	1005 (23.3)	136 (34.8)	—
Conjunctivalization Grade§			
0	24 (0.6)	3 (0.8)	169 (43.2)
1	75 (1.7)	4 (1.0)	83 (21.2)
2	743 (17.3)	40 (10.2)	97 (24.8)
3	3461 (80.4)	345 (88.0)	42 (10.8)
Lagophthalmos	98 (2.3)	11 (2.8)	1 (0.3)
Plica semilunaris			
Normal	1756 (40.7)	130 (33.3)	225 (57.5)
Scarred but not absent	1675 (38.9)	161 (41.2)	129 (33.0)
Effaced	879 (20.4)	100 (25.6)	37 (9.5)
Upper/lower lid symblepharon			
Present	505 (11.7)	64 (16.4)	1 (0.3)

Data are the number (%).

* Paired *t*-test comparing the nested case-control subjects: $P = 0.10$.

† BMI data available on 391 cases and 248 controls. *t*-Test for difference between mean BMI of cases ($n = 391$) and controls ($n = 248$); $P < 0.005$

‡ Tarsal conjunctiva not visualized in five TT patients and one control.

§ Lid margin not visualized in seven TT patients and one control.

lashes, or areas of absent lashes. Upper lid entropion was graded by assessing the degree of inward rotation of the eyelid margin (Supplementary Table S1, http://www.iovs.org/lookup/suppl/doi:10.1167/iovs.11-7880/-/DCSupplemental). The plica semilunaris was examined for scarring or effacement (Fig. 1d). The presence of symblepharon was recorded (Fig. 1e). The eyelid was everted and the position of the MCJ graded (Supplementary Fig. S1, http://www.iovs.org/lookup/suppl/doi:10.1167/iovs.11-7880/-/DCSupplemental). The MCJ is the junction between keratinized cutaneous epithelium and nonkeratinized conjunctival epithelium, which normally lies posterior to the meibomian gland orifices in the normal lid. Anteroplacement of the MCJ is referred to as "conjunctivalization" of the lid margin. Tarsal conjunctival papillary inflammation, follicles, and scarring were graded according to the Detailed WHO Trachoma Grading System (Follices, Papillae, Cicatricae [FPC]).[1] The presence of lagophthalmos was assessed by asking the patient to gently close his or her eyes. The reliability of the revised clinical signs grading system was assessed by interobserver comparison. The weighted κ score for specific signs was as follows: entropion 0.74, conjunctivalization of the lid margin 0.81, absolute number of metaplastic lashes 0.82, and absolute number of misdirected lashes 0.46. All subjects received treatment for their trichiasis as part of ongoing clinical trials, on the same day as the examination.

Data Analysis

Data were double entered into a database (MS Access; Microsoft, Redmond, WA) and analyzed (Stata 11; StataCorp. College Station, TX). The association of binary outcomes with exposures was assessed using generalized estimating equation (GEE) logistic regression to estimate odds ratios (ORs) and 95% confidence intervals (CIs), adjusted for within-person correlation. Ordinal logistic regression models with robust standard errors were used to estimate ORs and 95% CIs for the associations of ordered categorical outcomes with exposures. Variables that were associated with the outcome on univariate analyses ($P < 0.2$) were retained in the multivariable logistic regression model (GEE). The case–control data were analyzed using logistic regression analysis adjusted by the matched variables, to compare the frequency with which postulated clinical features of trachomatous trichiasis were found in cases and controls.

Results

Trichiasis Cases

We recruited 2556 consecutive patients with previously unoperated trichiasis in at least one eye. No individuals refused participation. All but one trichiasis case were of Amharan Ethiopian ethnicity. Demographic and clinical characteristics of participants are presented in Table 1. The mean age was 49.9 years and 72% were women. Among these 2556 individuals, there were 4310 eyes with previously unoperated trichiasis: 807 individuals had unilateral and 1752 had bilateral disease. Seventy-four individuals with bilateral disease had previously undergone trichiasis surgery on one of their eyes; these previously operated eyes were excluded from the analysis. Right (49.9%) and left eyes (50.1%) were equally affected. The median number of lashes touching the eyes with TT was 2 (range, 0 [epilating]–133; IQR, 1–5). Clinical evidence of epilation was found in 3013 (69.9%) eyes.

Entropion was absent or mild in 2328 (54.0%) eyes, moderate in 1259 (29.2%) eyes, and severe in 723 (16.8%) eyes (Table 1). The entropion was associated with visible conjunctival scarring in all but four eyelids. Three distinct patterns of trichiatic lashes were observed: metaplastic, misdirected, and secondary to entropion. Excluding eyes without lashes touching (successfully epilated), trichiasis was attributable to manifest entropion in 706 of (19.8%) 3572, whereas in the remaining 2866 (80.2%) eyes, it was attributable to aberrant lashes (Table 1). The relationship between the severity of entropion and the lash burden is shown in Table 2. There was a significant increasing trend in the severity of the trichiasis (lash burden) with increasing entropion grade (ordinal logistic regression, OR, 2.50; 95% CI, 2.29–2.73; $P < 0.005$). Similarly, lash type was strongly associated with entropion grade; 89.1% of those with entropion grade 3 or 4 had entropic (with or without aberrant) lashes, compared with none of those with entropion grade 0 or 1 (Table 2). The number of lashes touching the eye in lids with entropic TT was significantly greater than for lids with only aberrant lashes (Table 3; $P < 0.001$). Anteroplacement of the MCJ was very common in TT cases (Table 1). There was a strong association between increasing severity of entropion and more extensive conjunctivalization of the lid margin (Tables 4, 5). Lagophthalmos was seen in 98 (2.3%) of 4310 eyes with TT and occurred more frequently in eyes with severe conjunctival scarring (36/1005, 3.6%) than in those without severe scarring (62/3300, 1.9%; OR, 1.68; 95% CI, 1.05–2.70; $P = 0.03$).

Univariate and multivariable associations with severe entropion (grades 3 or 4) are shown in Table 6. The presence of severe entropion was independently associated with a BMI of less than 20, moderate or severe conjunctival inflammation

Table 2. The Relationship between Entropion Grade and Lash Burden and Type

	Entropion Grade				
	0	1	2	3	4
Characteristic	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Lash burden					
0 (epilating)	251 (25.8)	235 (17.9)	206 (16.0)	17 (4.1)	29 (9.5)
1–5	704 (69.1)	837 (63.8)	711 (56.5)	159 (38.2)	84 (27.4)
6–9	40 (3.9)	158 (12.0)	211 (16.8)	88 (21.2)	45 (14.7)
10–19	19 (2.0)	64 (4.9)	104 (8.3)	104 (25.0)	44 (14.3)
20+	2 (0.2)	18 (1.4)	27 (2.1)	48 (11.5)	105 (34.2)
Lash type					
None (epilating)	251 (24.7)	235 (17.9)	206 (16.4)	17 (4.1)	29 (9.5)
Metaplastic only	528 (52.0)	631 (48.1)	540 (42.9)	9 (2.2)	1 (0.3)
Misdirected only	167 (16.4)	256 (19.5)	272 (21.6)	14 (3.4)	1 (0.3)
Metaplastic + misdirected	70 (6.9)	190 (14.5)	179 (14.2)	8 (1.90)	0 (0.0)
Entropic with/without aberrant lashes*	0 (0)	0 (0)	62 (4.9)	368 (88.5)	276 (89.9)
Total	1018 (100)	1312 (100)	1257 (100)	416 (100)	307 (100)

* Metaplastic and/or misdirected

Table 3. Lash Burden by Type

Lash Burden	Metaplastic and/or Misdirected *n* (%)	Entropic (with/without Aberrant Lashes)* *n* (%)
1–5	2228 (77.8)	267 (37.8)
6–9	402 (14.0)	140 (19.8)
10–19	187 (6.5)	148 (21.0)
20+	49 (1.7)	151 (21.4)
Total*	2866 (100)	706 (100)

The individuals ($n = 738$) who successfully epilated all trichiatic lashes were excluded (no touching lashes).

* Metaplastic and/or misdirected.

(P2/P3), being female, age <50 years, central corneal opacity, and severe conjunctival scarring (C3). Plica semilunaris scarring (OR, 3.24; 95% CI, 2.88–3.65; $P < 0.001$) and symblepharon (OR, 3.32; 95% CI, 2.77–3.98; $P < 0.001$) were both significantly associated with severe conjunctival scarring.

Case–Control Comparison

For the nested case–control study, we recruited an additional 391 normal controls who were matched to 391 TT cases (who are included in the main analysis above). The demographic and clinical features of this subset of TT cases, and their matched normal controls are presented in Table 1. Univariate associations between various clinical features and presence of trichiasis are presented in Table 7. Conjunctivalization of the lid margin was strongly associated with TT (Table 7); however, there were some normal controls that also showed anteroplacement of the MCJ (Table 1).

Discussion

This clinical phenotyping study of trachomatous trichiasis in Ethiopia describes in detail the wide spectrum of disease manifestations and severity. TT is usually described in the literature as cicatricial entropion with the nonentropic forms of trichiasis largely not discussed.[1,26] However, in this study, we found that more than half the eyelids with TT had no or only mild entropion. In these cases, the trichiasis was due to either metaplastic or misdirected lashes.

Despite the lack of frank entropion in many TT cases, the eyelid margin in virtually all trichiasis patients was found to have some degree of anteroplacement of the MCJ (conjunctivalization). The degree of conjunctivalization of the lid margin was associated with the degree of entropion. In contrast, this lid margin change was seen much less frequently in the normal controls. In the normal eyelid the keratinized epithelium of the eyelid skin is expected to meet the nonkeratinized conjunctival epithelium (MCJ) just posterior to the meibomian gland openings and usually has a clearly defined right angle profile. In TT this sharp boundary is often lost, with rounding of the profile; the MCJ is often anterior to the meibomian gland orifices, which appear enveloped in abnormal epithelium. The nature and origin of this abnormal epithelium is not well characterized; it may be an intermediate type with features of both skin and conjunctiva.[27] A possible explanation for these changes is that the environment of the lid margin changes with increasing entropion; the skin comes into greater contact with tear fluid, which may contain factors that drive the migration of or transformation into a mucosal epithelial type.[28] The observation that a degree of conjunctivalization occurs in nearly all TT cases is interesting and suggests a very subtle or intermittent degree of entropion provoking this change. Entropion should be addressed surgically; however, it can be a difficult to assess. Relying on the position of lash follicles may be misleading in the presence of metaplastic lashes. The position of the MCJ and other lid margin changes, such as rounding, might be more objective markers for entropion and should be evaluated.

In most trachoma endemic settings, TT surgery is delivered by cadres other than ophthalmologists, who generally only receive limited training in one of the tarsal rotation procedures (BLTR or PLTR). These operations are specifically designed to treat upper lid entropion. In practice, in most countries it is not usually possible to deliver a surgical treatment that is tailored to the specific eyelid abnormality. The outcome of tarsal rotation surgery in eyelids without entropion has not been studied specifically. It is plausible that to deal effectively with TT due to aberrant lashes alone requires a greater degree of surgical external rotation (overcorrection) as the lid margin is effectively starting in a normal position. Failure to perform a sufficient overcorrection in such cases may account for much of the failure reported after TT surgery.[5–14] However, this should be balanced with the need to avoid a cosmetically unsatisfactory outcome, particularly in a group of patients who are generally younger and have mild disease. The consequences of tarsotomy surgery on the health of the cornea are also unclear; surgery is likely to compromise meibomian gland function and cause additional scarring in the tarsal conjunctiva. If aberrant

Table 5. The Relationship between Entropion Grade and the Presence of Grade 3 Lid Margin Conjunctivalization

Entropion Grade	Grade 3 Conjunctivalization OR	95% CI	*P*
0	1	—	—
1	1.52	1.26–1.84	<0.001
2	2.49	2.02–3.06	<0.001
3	3.66	2.60–5.17	<0.001
4	10.17	5.62–18.4	<0.001

Table 4. Entropion and Conjunctivalization of the Lid Margin

Conjunctivalization Grade	Entropion Grade 0	1	2	3	4	Total
0	16 (1.6)	2 (0.2)	6 (0.5)	0 (0.0)	0 (0.0)	24 (0.6)
1	41 (4.0)	18 (1.4)	12 (1.0)	4 (1.0)	0 (0.0)	75 (1.7)
2	256 (25.2)	266 (20.3)	170 (13.5)	39 (9.4)	12 (4.0)	743 (17.3)
3	703 (69.2)	1025 (78.2)	1071 (85.1)	373 (89.7)	289 (96.0)	3461 (80.4)
Total*	1016 (100)	1311 (100)	1259 (100)	416 (100)	301 (100)	4303 (100)

Data are the number of lids (%).

* MCJ position not visualized in seven lids

TABLE 6. Univariate Associations and a Multivariable Logistic Regression Model for Severe Entropion (Grades 3,4)

	Severe Entropion					
	Univariate Analysis			Multivariable Model		
Variable	OR	95% CI	*P*	OR	95% CI	*P*
BMI <20		1.09–1.63	0.005	1.35	1.10–1.67	0.005
Visual acuity >0.7 logMAR	1.85	1.53–2.23	<0.001	1.53	1.25–1.86	<0.001
Gender (female)	1.36	1.07–1.72	0.011	1.33	1.03–1.70	0.03
Age >50 y	0.83	0.68–1.01	0.063	0.63	0.50–0.78	<0.001
Moderate/severe inflammation, P2/P3	1.70	1.45–2.01	<0.001	1.57	1.32–1.86	<0.001
Central corneal opacity	2.56	2.14–3.07	<0.001	2.12	1.77–2.54	<0.001
Severe conjunctival scarring, C3	2.37	1.76–3.18	<0.001	2.00	1.48–2.68	<0.001

This analysis is of all 2556 trichiasis cases (4310 eyes), adjusted for bilateral cases by GEE.

lashes are not well corrected, it may be counterproductive, particularly in patients with only a few peripheral lashes, who are at low risk of developing corneal opacity.

The optimal management of mild TT is controversial, despite the WHO view that the presence of one trichiatic lash (irrespective of the degree of entropion) warrants tarsal rotation surgery. Many patients, particularly those with mild disease, decline surgery.[15–21] Many ophthalmologists and other eye care practitioners will defer operating, choosing to repeatedly epilate until more problematic TT develops; in The Gambia there has been a policy of only operating on lids with more than five trichiatic lashes.[20,29] Lash follicle ablation treatments such as laser or electrolysis are suitable for a few metaplastic or misdirected lashes and are widely used for aberrant lashes in well-resourced settings. These are not currently practical options in most trachoma-endemic locales. In a trial comparing a single treatment of electrolysis to the bilamellar tarsal rotation operation to treat mild TT, electrolysis was associated with higher rates of recurrence.[6] Electrolysis may have to be performed several times to attain equivalent results.

Severe entropion was independently associated with various factors. Unsurprisingly, it was linked to more severe disease phenotypes (conjunctival scarring, inflammation, and central corneal opacity). Women were more likely to have severe entropion. It has been frequently documented that women suffer from TT more frequently than men, which is generally attributed to a greater life time exposure to *C. trachomatis*.[30] Greater disease severity in women has not been previously reported, although this could have arisen from selection bias if women present later than men. The observation that severe entropion was more frequent in younger individuals is counterintuitive; again, there is the possibility of selection bias if younger individuals attend for surgery only when more severe disease develops or alternatively older individuals with more severe entropion had already received surgical treatment and therefore were excluded from this study. The mean BMI of people in this study was low. It was lower in TT cases than in controls and lower in individuals with severe entropion than in other less severe TT cases. Many risk factors for trachoma are linked to poverty, which is linked to malnutrition. The disability caused by trachoma (visual impairment and trichiasis) compounds poverty and poor nutrition. However, after adjusting for visual impairment, the association between a low BMI and severe entropion remained significant. This raises the possibility that there may be important nutritional factors that predispose to more severe disease.

TABLE 7. Univariate Associations (Stratified by Age, Sex and Location) between Various Clinical Features and Being a TT Case, Compared with the NC

	TT Case		
Variable	OR	95% CI	*P*
BMI <20	1.63	1.17–2.26	0.004
Lower lid trichiasis	16.70	5.97–46.7	<0.001
Severe (grade 3) conjunctivalization of the lid margin	92.31	54.2–157.2	<0.001
Lagophthalmos	14.34	1.82–113.1	0.011
Plica cicatrization	2.89	2.08–4.01	<0.001
Symblepharon	72.80	10.0–529.0	<0.001

Lower lid trichiasis occurs relatively frequently in TT patients (11.5%). It probably carries a similar risk of causing corneal damage as upper lid trichiasis. As with the upper lid, lower lid trichiasis can be due to aberrant or entropic lashes. There are no WHO guidelines on how to manage lower lid trichiasis. In most programs, TT surgeons are not usually taught how to perform lower lid surgery. Therefore, epilation is probably the only available management option in most trachoma-endemic settings. Plica semilunaris effacement has not been described previously in conjunction with TT. It is usually linked with ocular cicatricial pemphigoid, but is probably a nonspecific feature of severe ocular surface scarring.[31] Similarly symblepharon is not a commonly described feature of trachoma. TT surgeons should perhaps be taught to examine for it, as lid rotation surgery in the presence of symblepharon can be complex.

This study has the strength that a large number of individuals with TT were examined by a single observer. Extensive efforts were made to inform and identify patients with TT in the districts served by these surgical outreach campaigns. However, not all patients with TT in the study area have presented for treatment. Overall, we think that this group of patients is likely to be reasonably representative of TT patients in general. The male to female ratio is consistent with that in previous studies.[30] However, if individuals chose not to attend, it is probable that they had mild disease. The recruitment of controls in this hyperendemic region of Ethiopia is challenging. Only a minority of adults who were examined as potential controls were found to have no or limited conjunctival scarring. Therefore, to meet the various selection criteria, it was necessary to include some people with a minor degree of conjunctival scarring. The possibility that in some cases other etiologic factors may have contributed to the development of the conjunctival scarring and trichiasis in a few cases cannot be totally ruled out.

This study demonstrates the wide variation in the severity of TT and the degree of entropion that is found in a trachoma-endemic population. Many people had minimal or no entropion. Rather, they tended to have metaplastic or misdirected trichiatic lashes. The frequent anteroplacement of the MCJ, however, suggests that there were very subtle or intermittent entropion that caused conjunctivalization of the lid margin. The results of tarsal rotation surgery in patients without frank entropion warrant investigation, in comparison with alternative treatment strategies for mild disease.

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