Communications

Corneal anaesthesia after alcohol injection of the trigeminal sensory root

Examination of 100 anaesthetic corneae

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It is well known that lesions affecting the trigeminal nerve may lead to the development of neurotrophic keratitis (Magendie, 1824), but the incidence and the extent of the keratitis seen by biomicroscopic examination of the cornea, and in particular its effect upon visual acuity, are not well documented. The present study was undertaken to investigate these aspects of keratitis, in corneae rendered anaesthetic by alcohol injection of the trigeminal sensory root (henceforward referred to as Injection) (Penman and Smith, 1950; Penman, 1958).

Selection and examination of patients

97 patients were examined, 94 of whom had tic douloureux, and three migrainous trigeminal neuralgia. Three of the patients with tic douloureux had received bilateral Injections, making a total of 100 anaesthetic corneae. 86 of the patients were seen at Atkinson Morley's Hospital, and the other eleven came from the National Hospital for Nervous Diseases. Their ages at the time of examination ranged from 31 to 86 years, the majority (44 patients) being in the age group 60 to 69 (Table I). Females outnumbered males by 71 to 26, and right eyes outnumbered left by 72 to 28; these figures are in keeping with those for tic douloureux. Four patients suffered from disseminated sclerosis, the association of which with tic douloureux is well recognized, and one patient had syringomyelia which is also known to occur with tic douloureux; no other neurological disease was present, nor was any patient suffering from any relevant systemic illness.

Table I *Age and number of patients*

<i>Age (yrs)</i>	<i>No. of patients</i>
30-39 (youngest 31)	4
40-49	6
50-59	21
60-69	44
70-79	17
80-89 (oldest 86)	5
Total	97

Before Injection 45 patients had received treatment with Tegretol (carbamazepine) (Campbell, Graham, and Zilkha, 1966) for a time, either until the drug no longer alleviated their symptoms, or until they were forced by side-effects to discontinue it. A few had undergone unsuccessful surgery at an earlier date; in most cases this had been a peripheral neurectomy, but one patient had undergone a craniotomy. Cervical sympathectomy had been performed on one man 17 years earlier in an attempt to relieve his tic douloureux.

The length of time since Injection ranged from one month to 20 years, the largest group of patients (25) being seen after 5 years (Table II). The reason for this relatively large number seen at 5 years was that this was the last time patients were seen routinely for follow-up after Injection.

Table II *Number of eyes and time since injection*

<i>Time since injection</i>	<i>Months</i>				<i>Years</i>																<i>Total eyes</i>
	<i>Less than 1</i>	1-3	3-6	7-11	1	2	3	4	5	6	7	8	10	11	12	13	18	20			
No. of eyes	10	2	13	5	17	12	1	1	25	4	2	1	2	1	1	1	1	1	100		

Patients were examined when they attended the neurological outpatients department for routine follow-up after Injection. The criterion for inclusion in the study was that corneal sensation should be entirely absent; any patient with partial anaesthesia of the cornea was excluded. Initially an attempt was made to assess from the patient any ocular complications that occurred soon after the Injection, but this did not prove practicable, as in many cases Injection had been performed years previously, and any treatment required had been carried out at the patient's local hospital. It was therefore decided to record only the present or periodic symptoms and signs of which the patient complained. It was established that none of the patients had had previous tarsorrhaphies which had subsequently been opened.

Ocular examination

The visual acuity was recorded, and compared with that before Injection (in the great majority of patients this had been noted). A standard Schirmer's test was then carried out on both eyes simultaneously for 5 minutes, using a No. 1 filter paper. By this means the normal eye was used as part of the afferent pathway, to test the integrity of the afferent pathway on the normal side, and also to compare the resultant lacrimation on the two sides. Rowbotham (1939) emphasized that the greater superficial petrosal nerve may be damaged at the time of Injection. This was followed by an examination of the cornea and anterior segment with the slit-lamp microscope, which included staining of the corneal epithelium with fluorescein. Finally corneal sensation was tested using a Cochet-Bonnet aesthesiometer. With the patient seated at the slit lamp, the nylon thread was applied to the cornea at five points; at the centre, and 2 mm. from the limbus at the 12, 3, 6, and 9 o'clock meridians. Anaesthesia was considered to be complete if the patient was unable to feel indentation of the cornea by the nylon thread at a length of 5 mm.

Results

These were classified according to the visual acuity and the presence or absence of keratitis:

Group 1 No keratopathy.

Group 2 Evidence of keratopathy but good visual acuity.

Group 3 Keratopathy resulting in impairment of vision.

Group 1 (75 eyes)*(a) Visual acuity and examination of the cornea*

There was no evidence of keratitis at the time of examination, and apart from four eyes visual acuity was 6/12 or better; forty (54 per cent.) saw 6/6 or better, seventeen (23 per cent.) saw 6/9, fourteen (19 per cent.) saw 6/12. The remaining four eyes in which the vision was less than 6/12, showed other ocular disease, namely gross macular disturbances in two, advanced crystalline lens changes in one, and advanced tapeto-retinal degeneration in the fourth.

(b) Tarsorrhaphy

Four patients in this group had had lateral one-third tarsorrhaphies; it must be presumed that at some stage it had been considered necessary to carry this out. In the first patient (male, 59) it had been done 2 weeks after Injection, which had been performed 6 months previously. The second (female, 70) had been Injected a year earlier; tarsorrhaphy had been carried out only 2 weeks before she was examined but her cornea was entirely normal. Injection of the third patient (female, 50) had been performed 7 years previously, and tarsorrhaphy 3 years after Injection. The fourth patient (female, 50) had undergone tarsorrhaphy within a month of Injection carried out 7 months earlier.

Except for the second patient the tarsorrhaphies could probably be gradually opened.

(c) Symptoms

The only ocular complaints of patients in this group were few and non-specific, and were usually related to dysaesthesiae which not infrequently follow trigeminal denervation.

(d) Schirmer's test (Tables III and IV)

Table III shows the Schirmer readings from the control (normal) eyes, and Table IV the readings from the anaesthetic eyes. In Group 1 two patients had been injected on both sides, and three patients did not have Schirmer's test carried out; two of the three were unable to tolerate the filter paper in the control eye, and the third refused to have the test performed.

Table III shows that 37 per cent. of the control eyes gave readings of 5 mm. or less, and 40 per cent. gave readings of over 10 mm.

Table III *Schirmer's test in control eyes*

Schirmer's test results											Total readings
Group	5 mm. or less		6-10 mm.		11-15 mm.		16-20 mm.		over 20 mm.		
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	
1	25	37	16	23	10	14	8	12	10	14	70
2	9	50	3	17	5	27	1	6	—	—	18

Table IV (overleaf) shows that 39 per cent. of anaesthetic eyes gave readings over 10 mm. and 15 per cent. over 15 mm.

Table IV *Schirmer's test in anaesthetic eyes*

Schirmer's test results										Total readings	
Group	5 mm. or less		6-10 mm.		11-15 mm.		16-20 mm.		over 20 mm.		
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.		Per cent.
1	27	39	15	22	17	24	8	11	3	4	70
2	8	44	6	33	3	17	1	6	—	—	18

Among the patients in Group 1 on whom Schirmer's test was carried out, seven anaesthetic eyes gave readings of zero, two being in a patient bilaterally Injected. Of the other five, in one the control eye also gave a reading of zero. The second patient in Group 1 who had been bilaterally Injected gave readings of 5 mm. and 9 mm.

Group 2 (20 eyes)

(a) Visual acuity and examination of the cornea

There was punctate epithelial keratitis in these eyes (Table V) but, as in Group 1, visual acuity was 6/12 or better; seven patients (35 per cent.) saw 6/6 or better, seven (35 per cent.) saw 6/9, and six (30 per cent.) saw 6/12. The patient with confluent coarse punctate keratitis had a visual acuity of 6/5 unaided, and in the other cases the visual acuity appeared to be unrelated to the amount of punctate staining present, so that as in Group 1 impairment of vision was not attributable to damage to the cornea. When the keratitis was partial it was always confined to the lower part of the cornea. One of the two patients with medium punctate staining had a small leash of blood vessels growing into the cornea at 6 o'clock, but this coincided with an ingrowing lash which unknown to the patient must have been abrading the cornea since the Injection 6 years previously (this patient was one of two with a small lateral tarsorrhaphy). Three patients in this group had a single small linear opacity in the stroma; the aetiology of this is uncertain, but it may have indicated previous keratitis. Neither of the two patients in this group with a tarsorrhaphy showed any stromal changes.

Table V *Distribution of punctate epithelial keratitis in eyes of patients in Group 2*

Punctate epithelial keratitis	Partial (less than half)	Confluent
Fine	12	1
Medium	2	2
Coarse	2	1

(b) Tarsorrhaphy

Two patients in Group 2 had lateral one-third tarsorrhaphies. This had been carried out in the first patient (female, 70) within a few weeks of Injection, performed 6 months

previously. The second patient (female, 39) had been Injected 6 months ago, and tarsorrhaphy had been carried out 2 weeks later.

(c) *Symptoms*

As in Group 1 symptoms were few and non-specific and related to dysaesthesiae.

(d) *Schirmer's test*

Control Schirmer's readings were possible in only eighteen of this group, because one patient had been Injected bilaterally.

Table III shows that 50 per cent. of the control eyes gave readings less than 5 mm., 33 per cent. gave readings over 10 mm.

Table IV shows that 23 per cent. of the anaesthetic eyes gave readings over 10 mm., and 6 per cent. over 15 mm.

Of the twenty eyes in Group 2 on which Schirmer's test was carried out, four anaesthetic eyes gave readings of zero, and in two of these the reading from the control eye was also zero.

Group III (5 eyes)

(a) *Visual acuity and examination of the cornea*

In this group keratitis was present and the visual acuity was reduced to less than 6/12 because of corneal changes. Details of these patients are set out in Table VI, and other facts about them are described below.

Table VI *Details of five patients in Group 3*

Patient No.	Sex	Age (yrs)	Time since injection	Visual acuity	Schirmer's test		Tarsorrhaphy	Cornea	Other Ocular Pathology
					Control	Anaesthetic			
1	F	67	5 yrs	6/24	20	20	None	Medium punctate epithelial keratitis lower nasal quadrant	Trichiasis Bilateral epiphora
2	F	52	1 yr	6/18	8	6	Lateral 1/3 2 wks after injection	Coarse confluent punctate epithelial keratitis Vessels above and nasally	? Rosacea
3	F	70	5 yrs	6/36	—	—	Central 1/3 2 wks ago	Fine central punctate epithelial keratitis	—
4	F	66	5 yrs	6/18	5	5	Lateral 2/3 1 mth after Injection	Superficial vessels infero-nasally Central stromal nebula	Dacryocysto-rhinostomy + Epiphora
5	M	62	6 mths	Counting fingers	—	—	—	Severe neurotrophic keratitis	Uveitis

PATIENT 1

This woman aged 67 years complained of photophobia and she had bilateral epiphora. On the side of the Injection some lashes were abrading the cornea, for which she was

attending her local eye hospital. There was punctate staining of the cornea, but her poor visual acuity may have been partly due to epiphora and photophobia. She was mentally not normal.

PATIENT 2

This woman aged 52 years had neurotrophic keratitis as well as pre-existing corneal scarring. The appearance of the cornea was consistent with rosacea keratitis, but there were no obvious cutaneous manifestations of this condition.

PATIENT 3

This woman aged 70 years, who had been Injected 5 years previously, had no eye problems until 9 months before the examination; her eye had then been injured by a hair spray and not long afterwards exposed to smoke from a bonfire. She had since suffered from intermittent redness of the eye, and a central one-third tarsorrhaphy had been carried out 2 weeks earlier at her local hospital.

PATIENT 4

This woman aged 66 showed no active keratitis, but there was central stromal scarring. She had undergone a dacryocystorhinostomy on the side of the Injection a year before the Injection, but the epiphora had not been cured. She admitted to wiping and rubbing her eye frequently, and when seen in the clinic was accompanied by a strong aroma of alcohol. In the notes there was a history of excessive alcohol intake. A tarsorrhaphy had been performed a month after the Injection 5 years previously.

PATIENT 5

This man aged 52 had been seen at routine follow-up 5 months previously (one month after Injection) when his visual acuity was recorded as 6/6. On this occasion his vision was reduced to "counting fingers"; he was found to have a severe neurotrophic keratitis with secondary uveitis and was referred for immediate tarsorrhaphy. He stated that his eye had been bloodshot for 1 week, after exposure to a high wind on a sandy beach. He had decided to do nothing about it as it would have interrupted his holiday; he was in fact a rather simple man.

It can be seen that in two of these patients in Group 3 (Patients 1 and 4) there was other ocular pathology in addition to an anaesthetic cornea, and in a third (Patient 2) there may have been unrelated corneal disease superimposed on neurotrophic changes.

(b) *Schirmer's test*

It was possible to carry out Schirmer's test on only three patients in this group. Patient 3 had a recently performed central one-third tarsorrhaphy which made an accurate Schirmer test impossible, and Patient 5 had a severe neurotrophic keratitis. Little information was therefore forthcoming from the Schirmer tests (Tables III and IV). The control side gave a wetter reading than the anaesthetic side in one patient, and in the other two the results from the two sides were the same.

These five patients were aware that their vision was blurred, and the acuity in each had deteriorated since the Injection.

Discussion

Magendie (1824) was the first to describe degenerative changes in the cornea after section of the trigeminal nerve in animals; since then much work has been carried out to determine the aetiology of these changes, and many hypotheses have been put forward. Paton (1926) and Rowbotham (1939), while both considering that analgesia of the cornea was the essential primary factor, thought that desiccation played an important role. This concept was supported by de Haas (1962), but he went on to say that, important though desiccation is, its primary cause must be sought in changes in the tissues themselves. The best known hypotheses were summarized by Duke-Elder and Leigh (1965), who concluded by saying that abnormal cellular metabolism seemed to provide the most adequate explanation of the phenomenon of neurotrophic keratitis. According to this theory, trophic disturbances are due to the lack of normal peripheral antidromic activity; the anaesthesia is incidental but facilitates trauma which the abnormal cornea is unable to repair in the normal way.

The incidence of neurotrophic keratitis in lesions of the trigeminal nerve varies according to the site of the interruption of the pathway. Paton (1926) considered that it developed more rapidly in ganglionic and infraganglionic lesions, but said that it undoubtedly occurred in supraganglionic lesions and those affecting the bulbo-spinal roots and their related nuclei. After suboccipital rhizotomy the incidence is considerably reduced, and it has rarely been reported after medullary tractotomy (Guidetti 1950); in the latter operation fibres conducting pain are severed, but light touch is preserved (Sjöqvist 1937). Harris (1940), discussing the end-results of alcohol injection of the trigeminal root, said that neurotrophic keratitis was formerly a serious complication but went on to describe methods of diminishing the risk of its occurrence (see below). Penman (1950), reviewing the results of 82 intracranial (root) injections causing anaesthetic corneae, referred to the high incidence of keratitis; he reported the incidence of keratitis requiring tarsorrhaphy as 18.3 per cent. Pannabecker (1944), reviewing 878 operations of various kinds for trigeminal neuralgia, reported an overall incidence of corneal lesions of 18 per cent., but was unable to draw any conclusions about sensory root injections since his series included only four of them. Subtotal rhizotomy involving the ophthalmic division and total rhizotomy produced an incidence of corneal lesions of 25 and 30 per cent. respectively. The incidence of corneal lesions following operations for trigeminal neuralgia which produced corneal anaesthesia (434 in all) was 29 per cent., the figure rising even higher if orbicularis paralysis was also present. Of these, 13 per cent. of the lesions were mild, and in 17 per cent. the condition was a severe form of neurotrophic keratitis. In an effort to indicate the relative seriousness of the various lesions, an attempt was made to record the final visual acuity. This had to be done by means of correspondence with the patients (only half of whom replied), and therefore the data obtained, which merely stated whether the patient had "reading vision", were not of great value. Pannabecker (1944) found that keratitis developed in only about 25 per cent. of cases within the first week after operation, but in 80 per cent. the onset was within 6 months.

For neurotrophic keratitis, prophylaxis is far better than treatment (Pannabecker, 1944; Stookey and Ransohoff, 1959; Penman, 1960). Harris (1940) reported that stellate ganglionectomy diminished the liability to keratitis, and that trophic ulceration healed readily. Baker and Gottlieb (1959) referred to evidence produced by Dott at the Harvey Cushing Society Meeting in 1955 in which he stated that, when the superior cervical ganglion was removed in patients with anaesthetic corneae after alcohol injection of the

fifth nerve, not a single instance of corneal ulceration was noted in a fairly large series of patients. It is of interest that one of the patients in Group 1 (male, 61) had undergone cervical sympathectomy in an unsuccessful attempt to relieve his *tic douloureux* 17 years previously. Most surgeons agree that a pad and bandage is contraindicated. If the keratitis does not respond to conservative measures within a few days, tarsorrhaphy is the recommended treatment (Paton, 1926; Harris, 1940; Pannabecker, 1944; Stookey and Ransohoff, 1959; Penman, 1960). Harris (1940) found the risk of keratitis much diminished by the regular instillation of liquid paraffin drops four times a day, and many surgeons advocate a protective shield for the first few weeks of anaesthesia; protective side-pieces can be fitted to spectacle frames, and are more satisfactory because they do not move.

Analysis of results

Of the eyes examined, 75 per cent. had normal corneae with no evidence of any damage having been suffered as a result of corneal anaesthesia, nor was any visual impairment attributable to corneal damage. 20 per cent. of eyes showed evidence of neurotrophic keratitis but this was of mild degree in most cases and did not impair vision. In this group of patients slight stromal scarring was found in three cases only, and there was no evidence that it followed earlier neurotrophic keratitis. Patients in both these groups were unaware of any visual disturbance, and had no significant ocular symptoms. In the remaining 5 per cent. neurotrophic keratitis was severe enough to impair vision.

It can reasonably be assumed that some degree of trophic disturbance occurs in all anaesthetic corneae. The time and severity vary from case to case (*e.g.* the third patient in Group 3 who had no trouble for 5 years), but every patient runs the risk of developing neurotrophic keratitis at any time. The interest lies in trying to determine what factors may predispose to its development, and why in this series of 100 anaesthetic corneae only 5 per cent. should have developed serious trouble.

In the three groups there was no significant age difference between the patients, or in the length of time that had elapsed since the Injection. The great majority of patients were given the same precise and complete type-written instructions on care of the eye after Injection, with particular emphasis on the importance of not touching or rubbing the eye, or getting soap or other irritants in it. They were also instructed to test the vision in the eye each day, and to consult an ophthalmologist without delay if it was blurred for more than 24 hours. Occupation might be thought to be an important factor, but in this series there was no evidence that patients who worked out-of-doors or in a dusty atmosphere were more prone to develop keratitis. For instance, Group 1 included a paint-sprayer, a mattress-maker, a lathe worker in a metal workshop, an aircraft fitter, and a factory hand in a fibre-glass factory. Group 2 included two patients living in dry climates in Western Australia and Cyprus, each with only a small area of fine punctate keratitis and 6/6 visual acuity, and no ocular problems. All five patients in Group 3 lived an indoor life; all the females were housewives, and the fifth was retired.

If the patients in Group 1 are taken as the "control" group (as they all have normal corneae) there are certain differences between them and the patients in Group 2 in the results of the Schirmer tests.

From Table III, which shows the readings from the control eye, it can be seen that 50 per cent. of eyes in Group 2 gave readings of less than 5 mm. compared with 37 per cent. with similar readings in Group 1. In addition, whereas 40 per cent. of eyes in Group 1 gave readings over 10 mm., only 33 per cent. from Group 2 did so; moreover, no reading

was greater than 20 mm. in comparison with 14 per cent. in Group 1 which gave readings over 20 mm.

From Table IV, which shows the readings from the anaesthetic eyes, it can be seen that 39 per cent. of the eyes in Group 1 were over 10 mm. compared with 23 per cent. in Group 2; moreover 15 per cent. were over 15 mm., but only 6 per cent. gave similar readings in Group 2.

Together these results suggest that reflex lacrimation of patients in Group 1 is greater than that of those in Group 2.

Other differences between the patients in this series may be seen by comparing the patients in Groups 1 and 2 (those with normal corneae or minor degrees of keratitis) with the patients in Group 3 (those with more severe corneal damage). Two points emerge: (1) In two, and perhaps three, patients in Group 3 there was other ocular pathology which undoubtedly had an adverse effect upon the anaesthetic corneae. (2) Of the five patients in Group 3 three could not be regarded as psychologically normal.

Conclusions

(1) Reduced reflex lacrimal secretion is a factor in some patients in the development of neurotrophic keratitis. It is suggested that a Schirmer test be carried out on patients who are to undergo operative treatment which may result in corneal anaesthesia. By this means it may be possible to forecast which patients are more likely to develop neurotrophic keratitis, and extra care can be taken to warn them of the signs and symptoms which may indicate that it is developing.

(2) Trichiasis, any suspicion of blockage of the tear ducts, and any inflammatory or other condition of the cornea, existing before surgery of the trigeminal nerve, may increase the risk of postoperative neurotrophic keratitis. These conditions should be investigated and treated before operation is undertaken.

(3) Patients with personality defect or mental inadequacy are more likely to develop neurotrophic keratitis than normal individuals; they should be selected with particular care for surgery, and their progress watched with special vigilance.

(4) Although keratitis usually occurs within a short time of operation, trauma may precipitate it years later; if this is reported and dealt with promptly no permanent damage will result.

Summary

One hundred anaesthetic corneae in 97 patients were examined after alcohol injection of the trigeminal ganglion. 75 per cent. of corneae were normal. 20 per cent. showed some evidence of neurotrophic keratitis but this was of small degree and insufficient to reduce visual acuity. The remaining 5 per cent. showed permanent corneal changes and impairment of visual acuity. Possible factors influencing the onset and progress of the keratitis were decreased reflex lacrimation and trauma to the cornea.

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