DENERVATION OF THE LACRIMAL GLAND*

BY

JOHN WHITWELL

Moorfields Hospital and The London Hospital

THE surgical treatment of epiphora is now well established and on the whole satisfactory. A success rate of almost 90 per cent. can be expected for the operation of dacryocystorhinostomy (Stallard, 1950). There still remains a considerable number of cases where the puncta or canaliculi are strictured or absent, where the lacrimal sac is absent or grossly damaged, or where the inner canthus is severely deformed. Every clinic has its cases of chronic epiphora due to dacryocystectomy and to trauma or irradiation of the inner canthus. Although many operations, such as canaliculoplasty, conjunctivo-dacryocystostomy, and canaliculo-rhinostomy have been devised, they are often very time-consuming and the results are far from good.

Several operations have therefore been described for diminishing the secretion of tears. The removal of the palpebral lobe of the lacrimal gland was first performed by de Wecker (1891); the operation was made classical by Axenfeld (1911), and has recently been strongly advocated by Rycroft (1956). The operation is usually successful, but the occasional complication of keratoconjunctivitis sicca mars the usefulness of this procedure. Keratitis sicca following dacryoadenectomy has been reported by Kalt (1903), Knapp (1929), and Engelking (1928), and I have personally seen two cases. It is probable that the complication is more common than would be supposed from the literature, and that the fear of transforming a wet eye into a dry one accounts for the general reluctance of ophthalmologists to perform this simple operation.

Strebel (1936) attacked the palpebral lobe and the secretory ducts with diathermy. Jameson (1937) divided the lacrimal ductules sub-conjunctivally, an operation which can be graded in extent. It has not been possible to trace any long-term results of this operation. Exposure of the gland to x rays has been recommended by several workers (Hensen and Lorey, 1922; Hensen and Schäfer, 1924; Treiser, 1939), and some successful cases were reported. Tikhomirov (1935) described the injection of the palpebral lobe with alcohol.

Patients with epiphora do not suffer constant discomfort and when sitting quietly in a warm room in subdued illumination, have no troublesome watering. Tearing is noticed when in the cold, in a wind, in a stuffy atmosphere such as the cinema, or when concentrating on close work. It is reasonable to suppose, then, that the constant steady level of lacrimal secretion is sufficient to prevent corneal and conjunctival drying, while the reflex excess lacrimation is the main source of disability. The logical treatment would be to abolish this reflex lacrimal secretion.

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Nerve Supply to the Lacrimal Gland

The lacrimal nerve, the smallest of the three terminal branches of the ophthalmic division of the trigeminal nerve, enters the orbit through the superior orbital fissure lateral to the annulus of Zinn. The nerve runs forward above the superior margin of the lateral rectus muscle to enter the posterior edge of the gland. Before reaching the gland, the nerve is said to send an anastomotic twig to the zygomatic nerve. It passes through the gland, sending a few filaments to supply the gland substance, and ends by supplying sensory fibres to the skin and conjunctiva.

The facial nerve also supplies the gland. The exact central origin of the fibres is unknown, but they leave the brain in the *nervus intermedius* and at the geniculate ganglion pass into the greater superficial petrosal nerve. This joins the deep petrosal nerve to form the Vidian nerve, and the fibres thus reach the sphenopalatine ganglion. It is thought that the fibres relay here and that the post-ganglion fibres pass into the zygomatic branch of the maxillary nerve.

Since the detailed course of this nerve in the orbit is described very vaguely in anatomy text-books, several dissections of the human orbit were performed (Fig. 1).

FIG. 1.—Orbit, showing a well-marked zygomatic groove.

In all cases (six subjects), the zygomatic nerve entered the orbit about 5 mm. behind the anterior extremity of the inferior orbital fissure and ran

upwards, outwards, and forwards, usually making a groove in the zygomatic bone (the zygomatic groove). Henceforward, the anatomy is subject to some variation. The groove leads to a foramen which transmits the zygomatico-temporal nerve. Sometimes, the foramen is common to this nerve and the zygomatico-facial nerve, but the latter may enter the orbit as an already separate nerve. At this foramen, the lacrimal branch is given off, penetrates the periosteum, and enters the lateral aspect of the postero-inferior corner of the gland. This point is about 15 mm. behind the lateral orbital margin at the level of Whitnall's tubercle (Fig. 2, opposite).

In one dissection, the zygomatic groove was roofed over with bone and the lacrimal branch appeared to enter the gland directly from the bone (Fig. 3, opposite).

The other common variation is seen when the lacrimal nerve sends an anastomotic branch to join the lacrimal branch of the zygomatic. In these cases, the lacrimal branch penetrates the periosteum earlier and joins with the anastomotic branch to enter the *posterior* aspect of the postero-inferior corner.

In addition, minute orbital twigs are said to pass direct from the sphenopalatine ganglion to the gland through the inferior orbital fissure (Johnston and Whillis, 1942).

The sympathetic supplies the gland from the superior cervical ganglion through the carotid plexus. Fibres reach the gland along the lacrimal artery and along the deep petrosal nerve to follow the same path as the facial nerve fibres.

The role that these nerves play in the control of lacrimation is still not fully understood.

The lacrimal nerve is purely sensory in the reflex lacrimal path. Stimulation of the lacrimal nerve causes copious watering (Czermak, 1860), but stimulation of the distal end of the severed nerve has no effect (Reich, 1873).

Vulpian and Journiac (1879), by experimental methods, and Goldzieher (1894) clinically showed the seventh nerve to be the main secreto-motor supply.

Hutchinson (1876) reported the case of a woman aged 34 years with a right paralysis of the seventh nerve and deafness occurring suddenly 2 days after a confinement; this was associated with "paralysis of the lacrimal gland". In the temporal approach to the Gasserian ganglion, the extradural method carries the risk of damage to the great superficial petrosal nerve and consequent abolition of tearing on that side, while the intradural approach is devoid of this risk (Rowbotham, 1939).

The part that the sympathetic plays is more difficult to assess. Stimulation of the cervical sympathetic in animals has been found to produce copious tearing (Wolferz, 1871; Demtschenko, 1871), while Reich (1873) found variable results and Campos (1897) no effect at all. Duke-Elder (1942) concludes that the sympathetic is responsible for the basis level of tear

FIG. 2.—The lacrimal branch of the zygomatic nerve entering the lacrimal gland. Anteriorly the cut end of the compound ligament is seen at its insertion into Whitnall's tubercle. Also seen are the typical fascial strands uniting the gland to the periosteum.

FIG. 3.—The nerve supply of the lacrimal gland. In this specimen, the zygomatico-temporal nerve is roofed over by bone and the lacrimal branch enters the gland directly from the bone. No anastomosis with the lacrimal nerve was demonstrated.

secretion and the parasympathetic (facial fibres) for the reflex excess lacrimation. Whitnall (1932) gives a similar opinion.

The evidence shows that the parasympathetic secreto-motor fibres from

the seventh nerve are the ones to be divided if the troublesome reflex tearing is to be abolished.

Injection of the Spheno-palatine Ganglion.—Ruskin (1928, 1930) described the posterior palatine approach for the injection of this ganglion with alcohol, and reported a case of epiphora due to previous dacryocystectomy which he treated by this method. This procedure has the merit of speed and simplicity, but the very close proximity of the maxillary nerve and nasal, dental, and palatine branches would appear to render them very liable to injury.

Injection of the Lacrimal Branch of the Zygomatic Nerve.—Several cases of epiphora were treated by a trial injection of 1 per cent. procaine into the region of the secreto-motor nerve. The needle was inserted below the lateral canthal ligament and directed backwards and upwards along the line of the lateral orbital wall. It was hoped that the injection of the nerve with alcohol would be a quick, easy way of treating epiphora. The results of the procaine injections showed a rapid decrease of lacrimation as measured by Schirmer's test, but several patients complained of diplopia caused by lateral rectus involvement. This method of treatment was therefore abandoned.

Denervation of the Lacrimal Gland

This operation was designed to cut the lacrimal branch of the zygomatic nerve as it enters the lacrimal gland (Fig. 4, opposite).

Up to now, general anaesthesia has been employed. The lids are closed by a skin stitch near the centre of the lid margins. An incision about 1 inch long is made with a scalpel from the external canthus laterally, in the line of a skin fold. The incision is deepened to penetrate the orbicularis; the conjunctiva is included in the section and divided with scissors right back into the lateral fornix where it joins the bulbar conjunctiva. Two traction sutures inserted into the cut ends of the external canthus effect a rhomboidal exposure.

The orbital margin is then defined. Attached to Whitnall's tubercle is found a thick fibrous band comprising the lateral canthal ligament, the check ligament of the lateral rectus muscle, and the end of the lateral expansion of the levator palpebrae superioris. This fibrous band is cut as close as possible to the tubercle, immediately allowing a much bigger exposure. The lower pole of the orbital lobe lies immediately above the fibrous band extending downwards behind it, and the next step is to mobilize this part of the gland. It is best commenced by separating the gland from the periorbital in the region of the fronto-zygomatic suture, for here the gland is quite strongly anchored by fascial strands—the "inferior ligament of Schwalbe". The lateral expansion of the levator fascia is then defined and a small malleable copper retractor inserted immediately lateral to it and held by an assistant. In addition, a fine traction suture (000 black) through the lower pole of the gland facilitates the dissection by gentle elevation. The fascial strands of the "inferior ligament" can easily be mistaken for nerve filaments, but no attention should be paid to these until the dissection has reached a point at least half an inch posterior to the orbital margin. Close behind this point, the small neuro-vascular bundle will be seen to pass into the gland. The traction on the gland will give the

FIG. 4.—Steps in the dissection of the lower pole of the orbital lobe of the lacrimal gland.

course of the nerve a rather characteristic sickle shape as it obliquely penetrates the periosteum (Fig. 2). The portion of the gland which the nerve is entering (the postero-inferior corner) is grasped by a pair of Poirrier's tissue forceps. The nerve is divided as close to the periosteum as possible and the postero-inferior tip of the gland held by the tissue forceps is removed with scissors. If the nerve is not entering the lateral aspect of the gland, it will be seen entering the posterior aspect in conjunction with the anastomotic branch from the lacrimal nerve. Again, the nerve is divided and the tip of the gland excised.

With quiet anaesthesia, haemorrhage is not troublesome and the sucker is not usually needed.

The conjunctiva is closed by three silk sutures (000 black) on a Maddox needle and the skin is sutured with the same material. It has not been found necessary to insert any deep sutures. The wound is covered with tulle gras and an eye pad and a pressure bandage is applied for 48 hours. The lid stitch is then removed and the skin and conjunctival sutures on the fifth day.

Complications.—One case developed a small area of anaesthesia over the region of supply of the zygomatico-temporal nerve, due, no doubt, to an over-enthusiastic attempt to remove as much of the nerve as possible. No symptoms or signs of a sicca syndrome have been observed.

Results.—The operation has been performed on six patients.

Case 1, a male aged 20, had suffered from a watering right eye for 6 months. Investigations showed this to be due to inefficient drainage although no obstruction could be detected on syringing. A denervation of the lacrimal gland was attempted without benefit to the patient. The anatomy of the region was not fully understood at the time and it is likely that the nerve survived the onslaught.

Case 2, a female aged 56, suffered from epiphora after radium treatment to the inner canthus for a rodent ulcer. The canaliculi were completely occluded. An operation was performed but without benefit. She is awaiting a further operation.

Case 3, a male aged 52, had had a left dacryocystectomy performed at another hospital for recurrent dacryocystitis and was greatly troubled by the resultant epiphora. A left denervation of the lacrimal gland was performed with considerable improvement in his symptoms.

Case 4, a female aged 57, who had had a left dacryocystectomy performed 14 years previously, sought advice about the troublesome epiphora. A left denervation was performed and she is now symptom-free, volunteering the information that she can now peel onions without the left eye watering.

Case 5, a female aged 58, had a right epiphora of long standing. Investigation showed complete obstruction of both canaliculi about 3 mm. from the puncta. A left denervation was performed and she is now almost symptom-free.

Case 6, a male aged 63, had had a right facial palsy 3 years previously with partial recovery, but with persistent epiphora. The ducts were patent and the puncta in good apposition, so it was assumed that the muscular apparatus of the sac was inadequate. The lacrimal secretion as measured by Schirmer's test was reduced (see below) but was still sufficient to cause watering. A right denervation was performed and since then the patient has been little troubled.

In five cases, Schirmer's test was performed on the patients before and after the operation, the length of moistened filter paper being recorded in mms, after 5 minutes. In the post-operative test, the length of moistened strips was noted in the usual way after 5 minutes and then the patient was asked to sniff a bottle of strong ammonia. The strips were again noted 1 minute later. This was done to demonstrate the effect on the reflex lacrimal secretion, although it must be remembered that Schirmer's test mainly measures reflex lacrimation owing to the irritating effect of the paper. The findings are recorded in the following Table:

Case No.	Pre-operative Schirmer's Test (5 min.)		Post-operative Schirmer's Test			
			5-minute Test		1 minute after Ammonia	
	Right	Left	Right	Left	Right	Left
3	16	16	17	8	24	10
4	18	20	24	9	42	12
6	11	15	5	17	6	28

Conclusion

In cases of epiphora due to blockage of the lacrimal passages, it is the reflex tear secretion that is troublesome. When it is impossible to produce effective drainage, the operation described for cutting the secreto-motor supply to the lacrimal gland may produce considerable relief.

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