both following treatment of the chronic conjunctivitis and irritation associated with eyelid laxity.

Even under optimal situations, the quantitation of ptosis repair surgery is challenging. In patients with lax eyelids, chronic conjunctivitis, and chronic irritation the quantitation of the ptosis repair surgery can be made very inaccurate. Finally, in certain patients with severe upper eyelid laxity and severe upper eyelid ptosis, it is important to note the position of the floppy upper eyelid tarsal plate.

The present report is a thought provoking presentation of patients with chronic ocular irritation associated with eyelid laxity. Just as so called classic floppy eyelid syndrome and more recently eyelid imbrication may represent specific subtypes of patients' problems associated with eyelid laxity, it is important to recognise the different subtypes of chronic ocular irritation secondary to eyelid laxity.

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1 Culbertson WW, Ostler HB. The floppy eyelid syndrome. *Am J Ophthalmol* 1981; **92:** 568–75.
2 Culbertson WW, Tseng SCG. Corneal disorders in floppy eyelid syndrome. *Cornea* 1994; **13:** 33–42.
3 Karesh JW, Nirankari VS, Hameroff SB. Eyelid imbrication. An unrecognized cause of chronic ocular irritation. *Ophthalmology* 1993; **100:** 883–9.
4 Dutton JJ. Surgical management of floppy eyelid syndrome. *Am J Ophthalmol* 1985; **99:** 557–60.
5 Moore MB, Harrington J, McCulley JP. Floppy eyelid syndrome. Management including surgery. *Ophthalmology* 1986; **93:** 184–8.

The minified Goldmann applanation tonometer

For over a century we have witnessed much ingenious exploitation of physical principles in the development of tonometry. Maklakoff is credited with inventing the first practical tonometer.[1] Fick's refinement in 1888 laid the mathematical foundation that led to Hans Goldmann's low displacement applanation tonometer,[2] which remains an enduring standard. Nevertheless, the physical properties of the cornea are major factors affecting the accuracy of tonometry, the post-keratoplasty eye presenting unique difficulty. The paper on the minified Goldmann applanation tonometer (MGAT) in this issue of the journal addresses the problem of an applanation area, limited by sutures and the graft interface. The authors have produced an elegant study, worthy of the Goldmann tradition, and offer a simple solution: '. . . for that smaller parking space, use a smaller car . . .'

Glaucoma is one of the commonest reasons, after rejection, for graft failure, with one study reporting that up to one third of such failures are associated with increased intraocular pressure.[3] Until the work of Irvine and Kaufman it was virtually impossible to measure accurately intraocular pressure in patients with corneal disease.[4] Intraocular pressure measurement is not only important in protecting graft and optic nerve, but also in maintaining wound integrity and in detecting hypotony. Interestingly, an eloquent review by Kaufman implies that 25 years ago, in cases of corneal disease, the only way for most clinicians to tell if corneal oedema was secondary to raised intraocular pressure was by the response to treatment with Diamox.[5]

The Schiotz tonometer, which can double intraocular pressure on indentation, is not only unreliable, but grossly misleading.[5] The pneumotonometer is simple to use, permits continuous recording and, importantly, provides an objective reading, but has a tendency to read high at low intraocular pressure and low at high intraocular pressure. There is reason to doubt that this instrument functions as an applanation tonometer, that it follows the Imbert-Fick law, and that it can be used in any position without a gravity correction.[6] Neither has the Tono-Pen lived up to its early promise. Portable, compact, easy to calibrate and usable in varied positions, its disposable tip lowers infection risk and its digital readout minimises user bias. By virtue of its small contact diameter (1·5 mm) Rootman *et al* recommended its use for irregular corneas.[7] However, Minckler *et al* found significant discrepancy attributable to corneal disorder.[8] More damningly, Geyer *et al* found that the Tono-Pen consistently overestimated intraocular pressure in normal and post-keratoplasty eyes, and did so in an unpredictable manner that was not amenable to mathematical correction.[9]

The standard Goldmann tonometer is versatile, robust, accurate, and relatively inexpensive; in my experience it tends to age better than its more sophisticated electronic alternatives. By the simple expedient of reducing tip diameter from 7 mm to 4 mm, Menage *et al* have extended the applications of Goldmann's tonometer. The weight and location of plastic lost by minification are such that calibration characteristics are unchanged and the MGAT provides measurements that are virtually identical to the standard Goldmann tonometer.[10]

The MGAT is not easy to use. The perceived mires are reduced to two overlapping quarter circles, the alignment of which can present difficulty for the initiate. None the less, this is a useful addition to our diagnostic armoury, and results show that it is at least as accurate as its alternatives. One has the impression, scanning the authors' data, that results would be even more compelling (in favour of the MGAT) had they employed a concordance rather than correlation approach in their statistical analysis. The need to de-epithelialise the cornea in some cases was a necessary expedient given the frequency of measurement and does not detract from the value of this study. This study, however, does not solve the problem of intraocular pressure measurement in the presence of epithelial oedema (akin to applanating ice cream) and all methods of tonometry remain subject to error in eyes with significant corneal scarring and irregularity.

Suitable for applications other than the post-keratoplasty eye, the MGAT will be useful for infants, patients with tarsorrhaphy, congenital or acquired lid abnormality, blepharospasm, cicatrising disease, nystagmus, etc. Laboratory workers should also welcome this tool for a variety of animals with narrow palpebral apertures.

The MGAT solves one of the problems of tonometry in graft patients, that of limited space for applanation. Considerably less expensive, readily accessible to most units and potentially more versatile than its more complex alternatives, it also has a large number of clinical applications. However, the ultimate goal of precise, non-invasive, continuous measurement for patients remains elusive. Perhaps, with improving technology, the next decade will present us with a telemetric solution.

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1 Maklakoff. L'ophthalmotonometrie. *Arch Ophthalmol* 1885; **4:** 159.
2 Goldmann H. Un nouveau tonometre applanation. *Bull Mem Soc Fr Ophtalmol* 1954; **67:** 474.
3 Mackman G, Brightbill FS. Combined penetrating keratoplasty and mechanical anterior vitrectomy. *Ophthalmol Surg* 1980; **11:** 330–2.
4 Irvine AR, Kaufman HE. Intra-ocular pressure following penetrating keratoplasty. *Am J Ophthalmol* 1969; **68:** 835–44.
5 Kaufman HE. Pressure measurement: which tonometer? *Invest Ophthalmol* 1972; **11:** 80–5.
6 Moses RA, Grodzki WJ. The pneumotonograph, a laboratory study. *Arch Ophthalmol* 1979; **97:** 547.
7 Rootman DS, Insler MS, Thompson HW, Parelman J, Poland D, Unterman SR. Accuracy and precision of the Tono-pen in measuring intra-ocular pressure after keratoplasty and epikeratophakia and in scarred corneas. *Arch Ophthalmol* 1988; **106:** 1697–700.
8 Minckler DS, Baerveldt G, Heuer DK, Quillen-Thomas B, Walonker AF, Weiner J. Clinical evaluation of the oculab tono-pen. *Am J Ophthalmol* 1987; **104:** 168–73.
9 Geyer O, Mayron Y, Loewenstein A, Neudorfer M, Rothkoff L, Lazar M. Tono-pen tonometry in normal and in post-keratoplasty eyes. *Br J Ophthalmol* 1992; **76:** 538–40.
10 Kaufman PL, Davies GE. Minified Goldmann applanating prism for tonometry in monkeys and humans. *Arch Ophthalmol* 1980; **98:** 542–6.