Goldmann applanation tonometry versus i-care rebound tonometry

Anthony Josephson finds the accuracy of the i-care rebound tonometer compares favourably with Goldmann applanation tonometry.

The main purpose of my study was to compare the i-care tonometer to the Goldmann in terms of accuracy. Obviously when it comes to measuring IOP, accuracy is the most important aspect of any method of tonometry. However, there are other things to consider... patient comfort, repeatability (both inter and intra-practitioner) and who can actually use the device. So not only did I record the IOP readings from both instruments but I also asked all the patients to assign a comfort value from 1-5 for the Goldmann and for the i-care, where 1 was the most comfortable and 5 was the least. These values were assigned only after both methods had been performed.

Background
Goldmann applanation tonometry (GAT) is considered to be the gold standard when it comes to accuracy. When it comes to measuring IOP using a Goldmann tonometer, it is generally considered a very rapid process. However, the time needed to instil a local anaesthetic and fluorescein, set up the tonometer and make regular calibration checks can all add up. Many patients also get nervous when the 'blue light' is being pushed towards their eye, triggering a reflex mechanism to shut their eyes. Holding their lids open can help, but in some cases this may just not be possible and there is the attendant possibility that such action elevates the pressure. Thus it has to be used by a trained and experienced individual (usually an ophthalmologist or optometrist, although occasionally a nurse). It also has its risks; worst-case scenarios can lead to corneal abrasion or cross infection from patient to patient if non-disposable probes are not cleaned appropriately.

The Pulsair, or any other form of non-contact tonometer (NCT), is generally not considered as accurate as the Goldmann. While this may arise as a result of ophthalmologists’ impressions of optometrists’ over referral, the true reason for high false-positive rates is a mixture of low disease prevalence and over-reliance on tonometry per se. However, the results of the ‘puff of air’ test, which is how most patients will refer to it, can vary dramatically depending on how comfortable the patient is and the arterial pulse which can also affect the reading if the ‘puff’ just happens to catch the moment at which this occurs. This poses a problem; for example, how many readings should be taken before the overall average can actually be considered as accurate enough to count?

From personal experience I have found that many patients prefer the Goldmann to the Pulsair because the anaesthetic used in the Goldmann usually results in no sensation for the patient. This is especially true if proxymetacaine is the chosen anaesthetic. The Pulsair, on the other hand, can be quite alarming for many people. After one ‘puff’ many patients aren’t too keen for a second, let alone up to five. However, perhaps the main advantage of the Pulsair when compared to the Goldmann is the fact that clinical assistants can be trained to use it. This may also be a disadvantage in that it has, in some practices, reduced clinical decision making to a simple numerical exercise which exacerbates high false-positive referral rates.

The i-care
By comparison, a tonometer introduced in recent years, the i-care rebound tonometer, works by having a tiny plastic-tipped probe (of diameter 0.9mm) surrounded by a magnetic field. The handling of the device is much like the Pulsair we are familiar with, but without an eye piece to look through. The i-care works by measuring the deceleration of this probe at the moment it taps the cornea. The instrument is held about 5mm away from the apex of the cornea and the large button on the rear is depressed. This triggers the magnetic coil to ‘fire’ the probe forwards (Figures 1-3).

The contact time is so brief that no anaesthetic is used. Many patients feel no sensation at all from the probe, but for those who do the best way of describing it is ‘like a little tickle’. It may cause a reflex blink but very rarely anything more. The device itself is far lighter and more portable than the Pulsair tonometer. Obtaining an IOP measurement from a child using either the Pulsair or the Goldmann/Perkins (certainly not repeated measurements with the Pulsair) can be difficult. However with the i-care, due to the quick readings and minimal sensation felt, it is quite easy to do so. It is advised that six readings should be taken in each eye (and after a little practice these can be obtained quickly). The instrument itself...
keeps a running average on the screen for you, although the manufacturers claim it is usually more than adequate to accept the first reading. The instrument is self-calibrating. It disregards the highest and lowest of the six readings and averages out the middle four for its final value. It also presents a degree of accuracy of the readings using a small line on the display which can appear at three different levels or not at all. If the line is absent it means the accuracy is exceptionally good.

If the standard deviation of the individual measurements is less than 1.8mmHg, it is considered normal and no horizontal line is shown on the display (also the ‘P’ is not blinking). If the standard deviation is higher than normal, it is indicated by a blinking ‘P’ and a horizontal line after the ‘P’. There are three positions for the horizontal line: line down, line middle and line up, indicating a standard deviation of 1.8–2.5mmHg, 2.5–3.5mmHg and over 3.5mmHg, respectively. Neither the Goldmann nor common NCT types show standard deviation at the time of measurement.

Even though there is very brief contact with the cornea, it can be used by non-medically trained staff, much like the Pulsair. It also has the added bonus of not being affected by corneal scarring or imperfections which affect all the other techniques due to the need to align mires in order to get a reading.

Inter-tonometer comparison
After a little use it soon becomes clear that the i-care is an easy instrument to use. It feels comfortable for both patient and practitioner. So because it is comfortable, does that mean it is not accurate?

Well that certainly doesn’t seem to be the case. Previous studies have been made to compare the i-care with other tonometers. Roberts compared the i-care to the Pulsair and the Tonopen and found that the i-care’s results were very closely correlated to the Pulsair and that the i-care was the preferred method by the patients as it is more comfortable.

The latter part of the statement strongly agrees with the findings of this study. Iliev et al concluded that ‘64 per cent of the patients reported no discomfort at all, 36 per cent felt mild discomfort but no pain; none of the patients indicated moderate or severe discomfort or pain. i-care results and the relation to GAT were of the same order when performed under controlled conditions and in a real life clinical setting... the i-care can be considered a reliable alternative for clinical screening...’

Results
This study found remarkably similar results between the Goldmann and the i-care. Previous studies have seemed to suggest that perhaps the i-care gives a value slightly higher than the Goldmann tonometer. My data would suggest otherwise. Based on the comparison from 100 eyes (50 pairs of eyes) from a mix of males and females of a variety of ages in both the Hospital Eye Service and high-street practice, my findings are as follows.

Graph 1 shows a direct comparison between the readings from GAT and the i-care. There is a high degree of correlation as might be expected when comparing two instruments designed for the same purpose. Although commonly used for comparison it is difficult to see really how accurate the i-care is off a regression graph.

Graphs 2 and 3 show the difference between the i-care and GAT readings (I-G). Graph 2 is made up of the 100 comparisons all together, whereas Graph 3 is made up of two sets of data; one corresponding to 50 right-eye comparisons, the other corresponding to 50 left-eye comparisons.

It can be seen from these graphs that the vast majority of i-care readings were within +/- 2mmHg and the mode difference from the 100 comparisons was in fact zero.

Graph 4 shows the direct comfort comparison between the i-care and GAT, where 1 was the most comfortable and 5 the least. It came as no surprise to me that the vast majority of people found the i-care as comfortable as could be, and while most patients had no problem with GAT, it was not considered quite as comfortable as the i-care.

Finally, just a quick thanks to all the people at the Royal Victoria Infirmary, Newcastle and BBR Optometry, Hereford for supporting me while writing this article.

References
1. Statement by Markku Eräluoto of i-care Finland (formerly Tiolat Oy, Finland).
5. Anthony Josephson is completing his Masters degree at Manchester University and this study forms part of his dissertation.