The PT100 Non-Contact Tonometer

An independent review of the PT100

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Tonometry on the move

The Reichert PT100 Portable NCT

OPTICIAN follows optometrist **Ainsley Smith** as he trials a new portable non-contact tonometer both in his practice and on a domiciliary visit

The measurement of intraocular pressure (IOP) is an important part of the full eye examination. As well as providing useful baseline data for future examination of a patient's eye, the measurement of IOP has important implications in screening for eye disease.

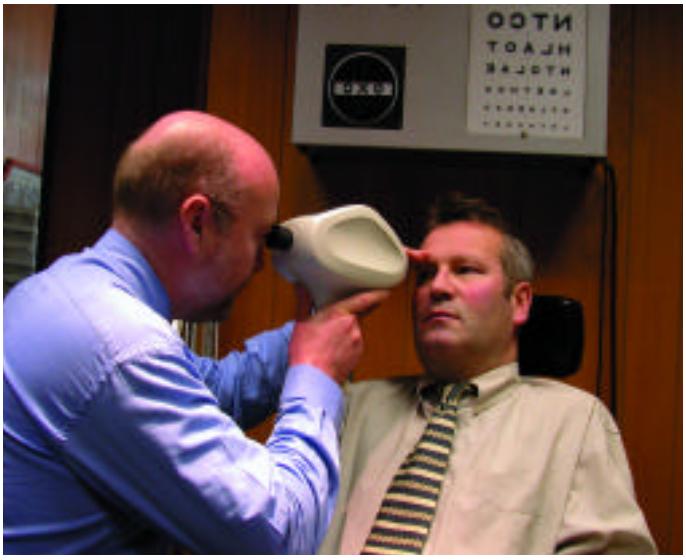
There is a well-established association between IOP and primary open-angle glaucoma. The insidious nature of the onset of this disease requires that an optometrist, routinely examining a patient's apparently healthy eyes, employs a variety of clinical techniques to assess ocular health. The measurement of IOP is one such technique and, as is often the case with a commonly used method, there are many ways to carry it out.

Since the phasing in of the Disability Discrimination Act 1995, the need for a portable instrument has been heightened. The clinical service offered to every patient should be as constant as possible irrespective of the potential wide range of ability of the patient, both in terms of mobility and access. There is also presently a very real issue regarding the age of the patient base in the UK.

The results of the National Census published recently showed the trend towards an ever-increasing life expectancy to be ongoing. A man in the UK now lives, on average, for 74.8 years, while a woman may expect to live until 79.8.

This has resulted in 25.5 per cent of the current UK population being over the standard retirement ages. It is reasonable to suggest that a great proportion of these people will be housebound and so unable to access clinical services unless a domiciliary provision is available.

Practitioners recognise age as the main risk factor for primary open-angle glaucoma. The measurement of another major risk factor, the IOP, is carried out on all patients unless absolutely impossible, certainly above a considered age limit (usually 30 to 40 years of age), as well as, in many cases, at the initial visit in order to establish a baseline reading.



Ainsley Smith using the PT100 in his practice

The importance of the IOP as a risk factor has enjoyed a variable emphasis over the years. The perception by the public that the 'puff of air test' was a 'test for glaucoma' was partly influenced by a willingness by many to equate raised intraocular pressure with glaucoma.

The existence of low-tension glaucoma and the advances in research regarding the link with intraocular bloodflow, mechanical influences due to ocular structure changes and the role of genetic factors have all required the influence of intraocular pressure to be put into context. So much so that at the start of the last decade reports were appearing suggesting that intraocular pressure was less than reliable as a predictor of glaucoma and greater emphasis should be placed on more sensitive field assessment and a better understanding of the underlying histopathological processes.

Though the importance of these developments should be accepted, the significance of regular and accurate tonometry measurement has been given a new impetus from recent findings regarding ocular hypertension.

The recent American Academy of Ophthalmology meeting in Orlando boasted several presentations of research suggesting that early intervention in cases of confirmed ocular hypertension resulted in a significant decrease in patients going on to develop glaucomatous signs of neuropathy. This would tend to lend great emphasis again to the importance of regular and accurate tonometry to all patients.

Bearing in mind the demographics of the UK, the availability of a portable and accurate tonometry technique is a key factor for future provision of ocular screening.

CURRENT PORTABLE TONOMETERS

Contact applanation tonometers rely upon a mechanical change, when contact with the eye is made, being interpreted as an indication of the pressure within the globe.

Such devices may be made very small and portable. A portable version of the

Goldmann tonometer, the Perkins handheld tonometer, has been available and widely used for many years and has been the mainstay of tonometry in domiciliary visits. More recently, the Tonopen, which uses a digital display of an electronic interpretation of the data upon contact with the eye, has been increasingly popular as it is easy to use and the small size means the instrument can literally fit into a top pocket. However, contact tonometry has its down side. The need for topical anaesthetic and the still ongoing concern over the significance of vCJD has meant adaptations to these techniques have been implemented (disposable probe heads or covers) and many practitioners would prefer a less invasive approach.

However, a prolonged contact does mean that some of the transient local fluctuations in IOP, as are caused by the ocular pulse or lid and eye muscle movements, are averaged out during the contact and the interpretation of them may even be used as a diagnostic aid.

The mechanism for production of an air column of known force or pressure and the interpretation of the flattened corneal surface require a typical non-contact tonometer to be of a certain size.

The original portable NCT, the Pulsair, addressed some of these issues with a freely moveable handset away from the body of the machine with the pump. The Pulsair has undergone several transitions and the latest incarnation, the Pulsair EasyEye, is the smallest and most portable yet. However, a yet smaller, and therefore more portable, NCT is now available.

THE INSTRUMENT

The Reichert PT100 was introduced on April 1 this year and is just becoming easily available on the UK market.

The first striking point about the instrument is its small size. Most non-contact tonometers are desktop instruments. The mechanism to produce the appropriate air pressure and patient alignment have, as already stated, limited the reduction in size of the instruments to date. The PT100 appears to have overcome some of these restrictions as the handset is just 25cm high, 12cm wide and 20cm deep and it weighs just 1.3kg once unpacked.

Another way that space has been saved is by providing a separate infra-red controlled printer. Once readings have been taken, the instrument may be pointed at the printer and the data will be printed out for insertion in a record card. The printer itself is battery operated and, together with the instrument itself, fits snugly into the carrying case provided making it highly portable.

FIGURE 2. The striking point about the PT100 handset is its small size – just 25cm high, 12cm wide and 20cm deep

All non-contact tonometers use a technique of measuring the air pressure (or in the first Reichert NCTs, the time taken to achieve the air pressure) required to flatten or applanate an area of cornea and then to extrapolate the intraocular pressure. A higher air pressure will be needed to applanate an eye with a high intraocular pressure. The instrument requires some feedback mechanism to identify at which point the cornea has been applanated by the specified amount and this relies upon the corneal integrity.

As the cornea flattens it represents more closely a plano mirror and hence will eventually reach a point where an incident beam, usually in the infra-red region, from the tonometer will be reflected into a transducer to shut off the air. This mechanism does rely upon both a good optical surface at the front of the cornea and pre-corneal film, and also a precise distance from the instrument to the corneal apex. A good alignment is essential. It is also important to remember that the split second taken to carry out a reading means that all NCTs are able to measure very accurately one point on a fluctuating curve of IOP. Just the ocular pulse itself may contribute variation of around 3mmHg, and factors such as blinking and eye movements may change readings further. For this reason it is essential that several readings are taken with NCTs and a consistent average reading used.

These basic principles apply to the PT100 and influence how it is operated.

USE OF THE PT100

As should be the case with all battery operated systems, the PT100 has a sleep mode. After two minutes of inactivity the system will shut down to conserve power and it is in this state that the instrument will be initially found. Activation is simply by pressing any of the six buttons found around the small LCD screen. A full charging of the battery takes around three hours and a full charge should allow for around 250 individual measurements to be made, though with some variation depending upon the set up of the instrument.

Pressing the set up button allows the operator to specify changes from the default setting. For example, it is possible to calibrate the instrument in both millimetres and kilopascals (should you wish to!). The patient eye may be illuminated to help centration in poor lighting conditions, though this setting will drain the battery much quicker. It is also possible to change the default infra-red transmission of data from the original target printer to another communication port, such as an appropriately set up laptop.

Once out of set up, the machine is then ready to take readings. The screen will display the level of charge in the battery, indicate to which eye the instrument is being directed and have spaces for the three readings to be taken and for the average to be displayed at the bottom of each list.

As with other instruments, there is a demo button which helps prepare the patient for the experience and an override button. This will allow the machine to fire on the basis of less critical measurements based on corneal reflection as is necessary for irregular corneas or for very poor fixaters. In most cases this should be avoided until no other way of achieving a reading has been found.

The screen displays the eye under

examination as it is approached. This camera system is very useful in allowing the practitioner to correctly orientate themselves and has long been a feature of desktop NCTs. A circle of eight arrows pointing inwards guides the user to the centre point while a colour-coded scale on the left of the screen indicates the proximity to the eye. Once the correct distance is reached and the instrument is correctly aligned, it fires automatically and a reading is displayed on screen. This process was made easier by using the spare hand to steady the instrument by placing it between the instrument and the patient brow. The patient should always maintain a steady fixation of the green dot target. Presumably this was chosen, as in other instruments, to allow good fixation without stimulating accommodation (another cause of localised IOP fluctuation).

In cases where a reading was taken with less than complete confidence, such as when there was much eye movement by the patient, or a reading was taken immediately subsequent to a blink, the reading will be displayed with an asterisk. If a reading is taken of more than 4mmHg difference to the average then it will be displayed in brackets. The practitioner might wish to take further readings or modify the average to exclude what may have been a rogue reading. If continued readings are taken, an improvement in the confidence of these will lead to them displacing those with an asterisk. Only three readings are displayed at any one time.

TIPS FOR USING THE PT100

The literature with the instrument is careful to point out that under no circumstances should it be operated by small children.

It is perhaps an endorsement of the instrument to state that the operation and setting of the instrument is so simple that it would not present any serious challenge for any child. However, any hand-held instrument requiring an accurate alignment and working distance requires some degree of control and practice is needed to be able to quickly take readings.

The author uses the instrument on many patients now and finds a reading is achieved almost instantly. Initially, it was often the case that several minutes (or what seemed to be longer) were needed before the machine would fire, despite all indications suggesting the correct position was held. This obviously may increase anxiety in an already nervous patient. As might be expected, however, repeated use decreased the time for the reading to be taken.

FIGURE 3. The machine is activated by pressing any of the six buttons around the screen

The manufacturers suggest the following points to improve the speed and accuracy of measurement:

- Slow movements should be used when aligning the instrument. The alignment system is very responsive
- The patient should ideally be at eye level with the practitioner (in the author's case, the technique was usually carried out seated)
- A headrest helps keep the patients head still
- After one reading has been taken, the practitioner should hold the instrument still to facilitate the hopefully smaller alignment needed for subsequent measurements
- Failure to take any readings may indicate the instrument requires cleaning and particular attention should be paid to the nosepiece. As this is the closest point to the patient, it is very easy for this to become dirty and influence the readings.

CONCLUSION

The extreme portability and ease of use, increasingly so after a few days' practice, make this a very attractive instrument to use. It will be interesting to see comparative trials of the measurements to assess accuracy, but the author has no qualms over the readings taken, having checked them with a Perkins in the domiciliary clinic. For practitioners wishing to have a flexible and portable instrument both within the practice and in allowing external clinics to be undertaken, the PT100 seems to be a very significant advance for NCTs and should prove most popular.

Hospital trial

The author usually carries out a morning clinic in a local hospital department where there are many elderly and infirm patients unable to access eye care services any other way. Previously, tonometry was carried out with a Perkins Mark II tonometer. Any unusual findings may be referred to a medical practitioner on site with some ophthalmologic experience and follow-up is usually quite efficient. The first morning the PT100 was used, nine patients in all were assessed and the following observations were made, based upon comments and views of both the practitioner and the patients. They are listed in the order they were taken down and in no way represent any particular priority.

- The portability meant the instrument was very easy to carry to the clinic. It was also very well suited to assess very infirm, wheelchair bound or even supine patients
- The instrument was felt to be less intimidating and patients did not seem overly concerned
- The 'puff' appeared less violent and none of the sample felt the instrument very uncomfortable
- The big green target was easy to fixate for those patients with reduced vision, even those with significant cataract
- The (lithium-ion) battery lasted long enough for a full morning session
- Access to the hard copy print out avoided any confusion if notes were added about several patients and the automatic inclusion of the time was useful
- There was no incidence of 'bumping' the patient with the instrument
- The practitioner suffered no arm fatigue by the end of the session
- The practitioner initially found the process of achieving a reading frustrating. If there is a tendency to hold one's breath while waiting, the initial stages of using the instrument may result in hypoxia!
- The override proved useful on several occasions where a reading was just not being reached
- The small size of the instrument was excellent, though the carrying case itself seemed unnecessarily bulky
- The buttons seemed to be placed logically for easy adjustment. For transmission to the printer, the print button needs to be continually depressed until the hour glass symbol disappears. This was not obvious initially.

Of the nine patients examined, just one refused to be measured, though she was of a very confused and nervous disposition and would not allow a Perkins assessment to be made either. Overall, the NCT averaged 2mmHg higher than the Perkins in this very small sample. However, one patient was found to have IOPs of 26mmHg in each eye consistently measured with the PT100. These were confirmed by the ophthalmologist using a Goldmann and she is now under treatment with ocular anti-hypertensive agents.