

Minimal cross-infection risk through Icare rebound tonometer probes: a useful tool for IOP-screenings in developing countries

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LABORATORY STUDY

Abstract

Aims Recently, a new rebound tonometer has been introduced into the market, which might be useful for glaucoma screenings in developing countries. Disposable probes, that are potentially reusable, are recommended by the manufacturer. Our study aimed to address the question of microbial transmission risks if the probes are reused.

Methods IOP measurements were obtained from 100 healthy eyes. The used probes were inoculated on broth and culture media. In addition, 10 probes were analyzed using environmental scanning electron microscopy in saturated hydrogen-steam atmosphere after usage and wipe disinfection technique with Sekusept 4% solution or Isopropanol 70%.

Results No bacterial or fungal growth could be detected in any of the inoculated agar plates or broth tubes. No microorganisms, clumps of cells, or single intact epithelium cells were detected in any of the probes using environmental scanning electron microscopy. Cell debris was detected on seven probes; three probes were completely free of any residual cell elements.

Conclusion Transmission of possibly infective material through reused probes is significantly less than for reusable Goldmann probes if the same sterilization protocols are applied. Re-usage of the probes appears safe and is helpful in avoiding unnecessary costs.

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Keywords: rebound tonometer; transmission; cross-infection; disinfection; glaucoma; developing countries

Introduction

The early diagnosis of glaucoma remains a major challenge all over the world but in particular in developing countries, where people generally present too late to save much meaningful vision.¹ Service providers of eye care in developing countries often reach out to the community and provide mass screening programmes combined either with treatment options at that place or the possibility to refer patients to the next eye hospital.² Handheld tonometers are of great benefit in the field, but normally require local anaesthetic drops to obtain a measurement. This is uncomfortable, takes time, and increases the risk of infection. The Icare (Icare Finland Oy, 02600 Espoo, Finland) is a modern rebound tonometer that does not need topical anaesthesia to obtain a measurement.^{3–7} The tonometer is based on a new measuring principle, in which a very light-weight probe makes momentary contact with the cornea. It can be used by assistant medical staff⁸ and shows a degree of agreement with Goldmann applanation tonometer (GAT), that is satisfactory for the purposes of identifying cases of significant elevation of intraocular pressure (IOP).^{9–12} The manufacturer of Icare recommends disposing of the tonometer probes after each measurement to minimize the risk of cross-infections. However, transmission risks and possible negative effects for patients have to

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be considered against unnecessary expenses. The head of the Icare probes is made of Polymethylmethacrylate (PMMA), the same material as the GAT heads, which are designed for multiple usage. To date no studies have been conducted to look at contaminations of the Icare probes after measurement.

We used culture techniques and environmental scanning electron microscopy (ESEM XL 30, Philips Company, Netherlands) to find out regarding possible contamination of the probes after usage. Ethical approval was obtained from the ethical committee of the University of Nairobi, Kenya. Informed consent from participants was obtained.

Materials and methods

Rebound tonometer Icare

The Icare tonometer uses an induction-based rebound method. A light-weight tonometer probe is accelerated against the patient's cornea. The velocity of the rebounding probe is measured by a specially designed coil and the IOP calculated. Corneal anaesthesia is not required. The Icare probe consists of a round PMMA head with a diameter of 1.7 mm and a 40 mm long metal shaft. During measurement the anterior part of the plastic head is in momentary contact with the cornea. The physical principles are described in detail elsewhere.¹³

Study participants and microbiological analysis

In all, 50 healthy individuals (medical students of University of Nairobi) underwent IOP measurement of both eyes with the Icare tonometer. Unused, originally packed probes were used for each measurement. As expected, the blink reflex was activated in some people, some so much so that the probe occasionally touched the conjunctiva or even lid-skin. Two Icare probes were used to measure IOP from each eye of the study participants. The first Icare probe was immediately inoculated on a Blood Agar plate and the second Icare probe was inoculated in brain heart infusion (BHI). The following microbiology protocol was used:

- (1) The Blood Agar plate was inoculated at 37 °C under raised carbon dioxide system for 18–24 h, whereas the BHI tubes were incubated under ambient conditions for 18–24 h.
- (2) On day 2, the contents of each BHI tube were divided between and sub-cultured on a Blood agar plate, a Chocolate Blood agar plate (CBA) and a MacConkey agar for bacterial pathogens and an additional plate of Sabourauds Dextrose agar (SDA) for fungal pathogens.

- (3) Subsequently, these plates were incubated in a microaerophile environment for 72 h. The Sabouraud agar plates were incubated at 30 °C for up to 14 days and evaluated for growth on days 1, 5, and 14.

Environmental scanning electron microscopy analysis

IOP measurements were obtained from 10 healthy eyes of 10 individuals. All 10 probes were disinfected subsequently. In five probes, we used wipe disinfection technique with Sekusept 4% solution, in the remaining five, Isopropanol 70%. After wipe disinfection, the probes were rinsed with Aqua dest. and left to dry. Sekusept is a disinfective agent containing 10% Natriumperborat and 10% Tetracetylglucoluril. It is recommended for disinfection of GAT heads in Germany. The probes were analyzed by environmental scanning electron microscopy in saturated hydrogen-steam atmosphere. The grade of contamination on the probes was recorded and grouped into categories.

Results

Microbial cultures of Icare probes

There was no growth in any of the 100 directly inoculated blood agar plates after 5 days of incubation for bacterial contamination. No fungal or bacterial growth was detected in the 100 BHI tubes or in any of the subsequently sub-cultured plates.

Environmental scanning electron microscopy analysis

No microorganisms, clumps of cells, or single intact epithelium cells were detected on any of the probes. Seven out of the 10 Icare probes showed signs of remaining cell elements on their surface after disinfection (Figures 1–5). Three probes were completely free of any residual cell elements (Table 1). There was no statistical difference in the amount of residual cell elements in the probes being disinfected with Sekusept from the ones being disinfected with Isopropanol.

Discussion

Safe, fast, and accurate measurement of IOP may be an efficient way to find people at risk of developing glaucomatous visual loss. In developing countries, these IOP screenings can be carried out independently or during routine outreach activities, for example, while screening for cataract cases. The IOP measurement should be quick, minimally traumatic, reproducible, and the risk of infective transmission minimal. So far, none of the available instruments satisfies these criteria fully. Recently, a new rebound tonometer has been introduced

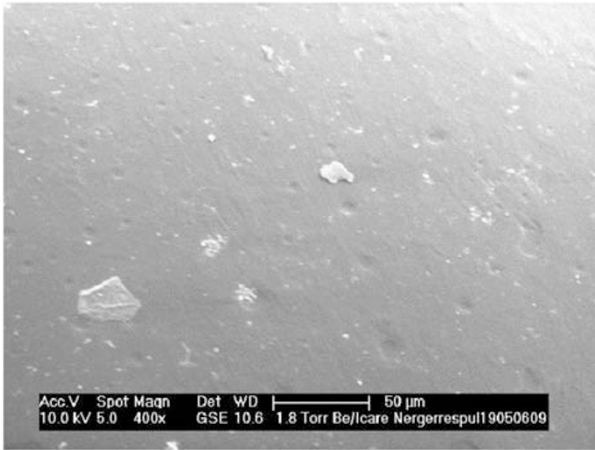


Figure 1 Few epithelium cell debris (keratin).

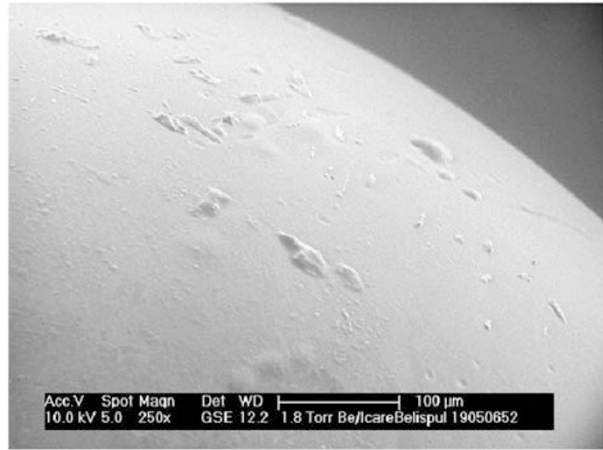


Figure 4 Localized contamination with epithelium cell debris.

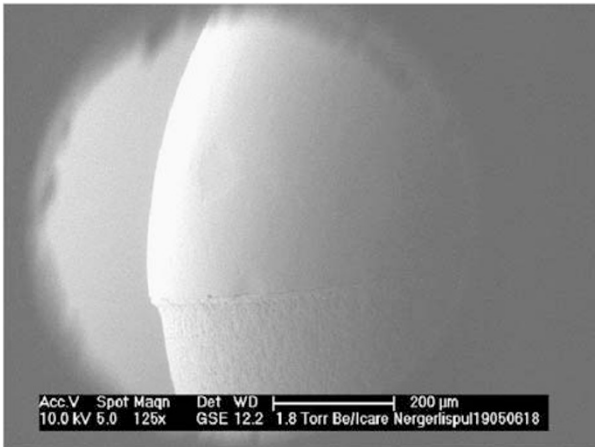


Figure 2 Shiny surface: no contamination.

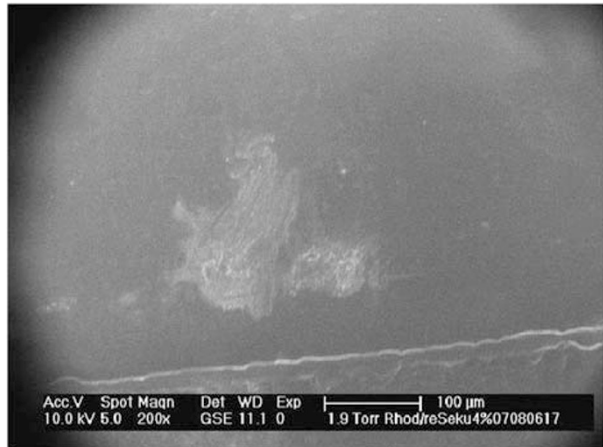


Figure 5 No cell debris, cleaning artifacts.

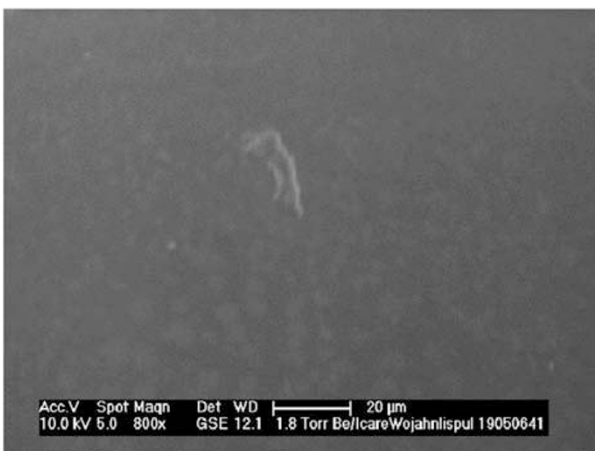


Figure 3 Dehydrated cell remnant.

in the market using disposable probes that are potentially reusable if disinfected. The transmission risk of these probes has not yet been studied. However, the microbial

Table 1 Grade of contamination of cleaned Icare probes

	Cell remnants		
	None	Few ^a	Moderate ^b
Isopropanol 70%	1	3	1
Sekusept 4%	2	3	0
Total	3	6	1

^aOne to three cell remnants per view field (200 µm²).

^bMore than three cell remnants per view field (200 µm²).

contamination of conventional contact tonometer heads and contact lenses and the efficiency of various disinfection techniques have been studied at several occasions.^{14–23}

The efficiency varies among studies, but most investigators agree that common disinfection techniques are effective against a wide range of microorganisms and viruses, with the exception of Acanthamoebae, which require longer soak times.²⁰ So far there have

not been any proven studies confirming iatrogenic transmission of Prions, Hepatitis C-, or HI-Virus through tonometer tips.^{21–23}

The infectious risk depends on the amount of fluids transmitted; the smaller the contact surface, the smaller the possible risk of infection.²⁴ The Icare tonometer probe has a diameter of 1.7 mm and surface area of approximately 4.6 mm². The standard Goldmann heads have a diameter of 6 mm and surface area of 28.3 mm². During measurement with the Goldmann tonometer, the cornea is flattened and the entire anterior surface is in contact with both the tearfilm and the corneal epithelium. In contrast, the Icare probes are accelerated against the cornea and rebound. The contact area depends on how deep the probe penetrates into the tearfilm and whether the probe deforms the corneal surface or not. This will vary with the IOP and corneal rigidity; their exact physical calculations are very complex and are beyond the scope of this article. However, even if it is assumed that the whole anterior part of the probe gains contact with the tearfilm, the contamination area will still be around 6 times less than for the Goldmann tonometer. In addition, the convex surface of the Icare probe will further decrease fluid accumulation on the probes. The more trauma involved in taking the reading, the more material (cellular debris, mucus, and tear fluid) will accumulate on the probe. Measurement with the Icare is much less traumatic and this reduces the risk of transmission.

In our study, no microorganisms could be cultivated from the used, uncleaned probes using standard culture techniques. Cleaning has been estimated to further reduce infectivity by four logs.^{20,24,25} Virus contamination could not directly be examined in this study. Adenovirus infections, although generally self-limiting, remain a matter of concern. The Adenovirus is highly contagious and some epidemics have been shown to originate from eye units.²⁶ Some studies have suggested that tonometry may be the source.^{27,28}

However, it is believed that transmission is caused rather through the hands of the tonometrist than through properly disinfected tonometer heads.^{19,29} Instilling anaesthetic drops and manual manipulation on the patients lids or conjunctiva are not necessary when taking IOP with the Icare tonometer and this will help lowering risks of adenovirus cross-infections.

In our study, minimal cell debris, mainly keratin from the epithelium surface, were detected by electron microscopy after cleaning. Viruses are unlikely to survive standard disinfection protocols in the absence of protective cell material or fluid.^{22,23,29} If this is the case, disinfected Icare probes should be fairly free of any known viruses. However, this assumption will require further research. Neither wiping nor rinsing under water removes cellular material completely and if the presence

of cell debris is taken as a measure of potential infectivity, none of the current cleaning and disinfection strategies is effective to eliminate transmission risk fully.

Considering the practical benefits and applications of this machine, it appears justifiable to tolerate a very minimal transmission risk considering the great benefit for a patient being diagnosed at an early stage of glaucoma avoiding irreversible damage to the eye. The correct, safe use of this new rebound tonometer could have a great effect on early detection of the glaucoma, especially in developing countries.

Our study has some limitations. We did not analyze possible contamination risks if eyes with surface pathologies, for example, bacterial conjunctivitis or corneal ulcers are measured. In such cases, it seems reasonable to dispose the probes as there is likely to be a much higher infectious risk. Further studies are needed to determine the contamination risk in those circumstances.

Practical aspects in the disinfection of the Icare probes were not analyzed in this study. Care has to be taken not to bend the probes during disinfection. Surfaces that appear smooth macroscopically will develop microscopic surface irregularities with time and use. These irregularities will increase contamination risks and it seems reasonable to replace probes after a limited number of measurements.

Summary

What was known before

- Disinfection protocols for conventional tonometer heads exist and their efficiency has been proven.

What this study adds

- Icare tonometer heads carry a minimal cross-infection risk if disinfected and reused. Common disinfection protocols can be applied on Icare heads and this will lower costs of IOP measurements.
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Conflict of interest

The authors declare no conflict of interest.

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