Self-illuminating 'glow-in-the-dark' vitrectomy trocar cannulas: A pilot study

Authors:

1. Dr WengOnn Chan[1,2] MPhil, FRANZCO
2. Dr Melissa Shields[2] MBBS (corresponding author)
   Email: melissa.kate.ellis@gmail.com
   Ph. (+61) 422 453 838
3. Prof Robert Casson[1] DPhil, FRANZCO
4. Dr Shane Durkin[1,2] MBBS, FRANZCO

1. *The Royal Adelaide Hospital, North Terrace, Adelaide, South Australia 5000*
2. *The Queen Elizabeth Hospital, 28 Woodville Rd, Woodville South, South Australia 5011*

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MANUSCRIPT

During small-guage, sutureless pars plana vitrectomy (PPV), sclerotomies are maintained by cannulas comprising an internal micro-cannula and an external overcap. The use of trocar cannulas during PPV facilitates smooth transition of instruments into the posterior segment and reduces trauma. However, room lighting is routinely dimmed during PPV and visualisation of the ports can be difficult, compromising efficient instrument exchange.

We constructed phosphorescent "glow-in-the-dark" 25-guage trocar cannulas (GIDTC), hypothesizing that instrument exchange under simulated VR lighting conditions would be more efficient with GIDTC than standard 25-guage trocar cannulas (STC). Ethics approval for this study was obtained from the Central Adelaide Local Health Network Human Research Ethics Committee. Participants were South Australian medical officers grouped by level of VR surgical experience. Group one comprised participants who had independently completed at least 50 PPVs. Group two comprised participants who had observed at least 20 ophthalmic microsurgical procedures. Figure 1 shows a comparison of the STC and GIDTC in mesopic conditions. Standard VR operating theatre lighting conditions were measured with a photometer and replicated during the study. Each participant completed an instrument exchange 5 times with each cannula in random order under photopic (>200 lux) and mesopic (2.0 – 3.0 lux) conditions. An error was recorded if an instrument made contact with the model eye or the cannula overcap. Outcome measures were the time to task completion and number of errors. All attempts were video recorded and an observer documented the time taken and the number of errors made (Figure 2). Statistical analyses were performed with paired t-tests.

A total of 19 participants completed the practical task (n = 7 in Group 1 and n = 12 in Group 2). Mean time to task completion was significantly lower using the GIDTC under photopic ($p = 0.001$) and mesopic conditions ($p < 0.001$). In mesopic conditions, the mean time with the SC was 11.9 seconds (SD 5.5) and with GIDTC was 5.1 seconds (SD 1.3). Mean time to task

completion in photopic conditions using the STC was 5.3 seconds (SD 1.3) and GIDTC was 4.2 seconds (SD 1.3) (P value < 0.0001). The VR group had significantly fewer touch errors than the non-VR group ($P < 0.05$). There were significantly lower error counts per attempt in mesopic conditions with GIDT ($p < 0.001$), but not under photopic conditions.

Small sample size is a limitation of this study; however, there was a clear and significant reduction in mean time to task completion with GIDTC in both the VR and non-VR groups, suggesting that GIDTC use has the potential to reduce procedure time for both experienced VR surgeons and surgical trainees. Under mesopic conditions, ocular touch errors are also reduced by the use of the phosphorescent cannulas. Self-illuminating cannulas for small-guage PPV decrease procedure time and reduce error rates during low-light instrument exchange. The benefits of these instruments potentially extend to both experienced and inexperienced VR surgeons.

Legend

FIGURE 1. Side by side comparison of ST and GIDT under mesopic conditions.

FIGURE 2. IR footage of ST under mesopic conditions.

FIGURE 3. Box plot demonstrating mean time to task completion in mesopic (2.0 – 3.0 lux) and photopic (> 200 lux) conditions for standard and glow-in-the-dark trocars.

TABLE 1. Mean time to task completion and mean error count in mesopic (2.0 – 3.0 lux) and photopic (> 200 lux) conditions for standard and glow-in-the-dark trocars.