A SMART VITRECTOR equipped by a fiber-based OCT sensor mitigates intentional attempts at creating iatrogenic retinal breaks during vitrectomy in pigs

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Purpose

▪ Iatrogenic retinal breaks (IRB) is a pars plana vitrectomy (PPV) complication that compromises the overall efficacy of the surgery.
▪ A subset of IRB occurs when the retina is cut accidentally by the vitrector.
▪ We developed a smart vitrector that detects in real-time potential IRB and activates promptly a PPV machine response to prevent them.

Methods

▪ We fabricated the smart vitrectors by attaching a miniaturised fiber-based OCT sensor on commercial vitrectors (25G).
▪ It provides real-time feedback to the PPV machine and requires no visual or audio signal interpretation by surgeons.

Results

▪ The response time of the system (28.9 ± 6.5 ms) is 12-times shorter compared to that of an average surgeon (p < 0.0001)

▪ Indicatively, for 5000 cpm, “post-deactivation decision” cuts can be reduced from 33 “cuts” (average surgeon) to 2.4 “cuts” (smart vitrector).

▪ Of the 54 trials to exert damage to the retina, 3 (5.56%) resulted in damage, damage was prevented in 30 (55.56%), prevented or mitigated in 38 (70.37%), while the procedure was terminated early (false positive) in 13 (24.07%)

▪ The smart vitrector can mitigate a subset of IRB in PPV.
▪ It is compatible with the established PPV procedure and instrumentation.

Validation

▪ The system’s response time to an IRB onset was measured and compared to that of the average surgeon.

▪ Two surgeons validated its ability to prevent simulated IRB by performing PPV in 2 pigs.

▪ IRB scenarios were simulated by aggressive approaches of the smart vitrector towards a detached, mobile retina with an intention to injure (“bite”) it.

Conclusions

▪ Of the 54 trials to exert damage to the retina, 3 (5.56%) resulted in damage, damage was prevented in 30 (55.56%), prevented or mitigated in 38 (70.37%), while the procedure was terminated early (false positive) in 13 (24.07%)

▪ 92.68% success rate (95% CI: 80.08 – 98.46) when not considering false positives or 70.37% (38/54) (95% CI: 56.39 – 82.02) using a ‘false positive equals failure’ approach.