



Minimally invasive subretinal perfluorocarbon liquid removal

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INTRODUCTION/AIMS

Retained subretinal perfluorocarbon liquid (PFCL) is a rare but vision-threatening complication of vitreoretinal surgery. Existing removal techniques can be invasive and risk retinal trauma. We evaluated ultrafine stainless steel microneedles (up to 49G) as a minimally invasive approach for direct PFCL aspiration.

MATERIAL & METHODS

Three-stage translational study design: In vitro

- Compared PFCL aspiration using 30G, 41G, 43G and 49G needles.
- Measured aspiration efficiency and needle patency under varying vacuum pressures.

Ex vivo porcine model

- Simulated subretinal PFCL removal using microneedles.
- OCT used to confirm PFCL removal and assess retinal effects.

Clinical series (n=10)

- Pars plana vitrectomy with 49G microneedle aspiration in eyes with subfoveal/parafoveal retained PFCL.
- Outcomes: technical success, visual acuity change, structural OCT findings.

Results

Bench / Ex Vivo (Fig. 1-2)

- All gauges successfully aspirated PFCL without blockage.
- 49G microneedle required higher vacuum (650 mmHg) but enabled controlled aspiration.
- Ex vivo removal reproducibly achieved with OCT.

Clinical (Fig. 3-4, Table 1)

- **100% technical success** (10/10 eyes)
- Mean visual acuity improvement: **LogMAR -0.08 ± 0.12**
- No detectable wound-related structural changes on OCT
- Self-sealing microneedle entry site observed

RESULTS

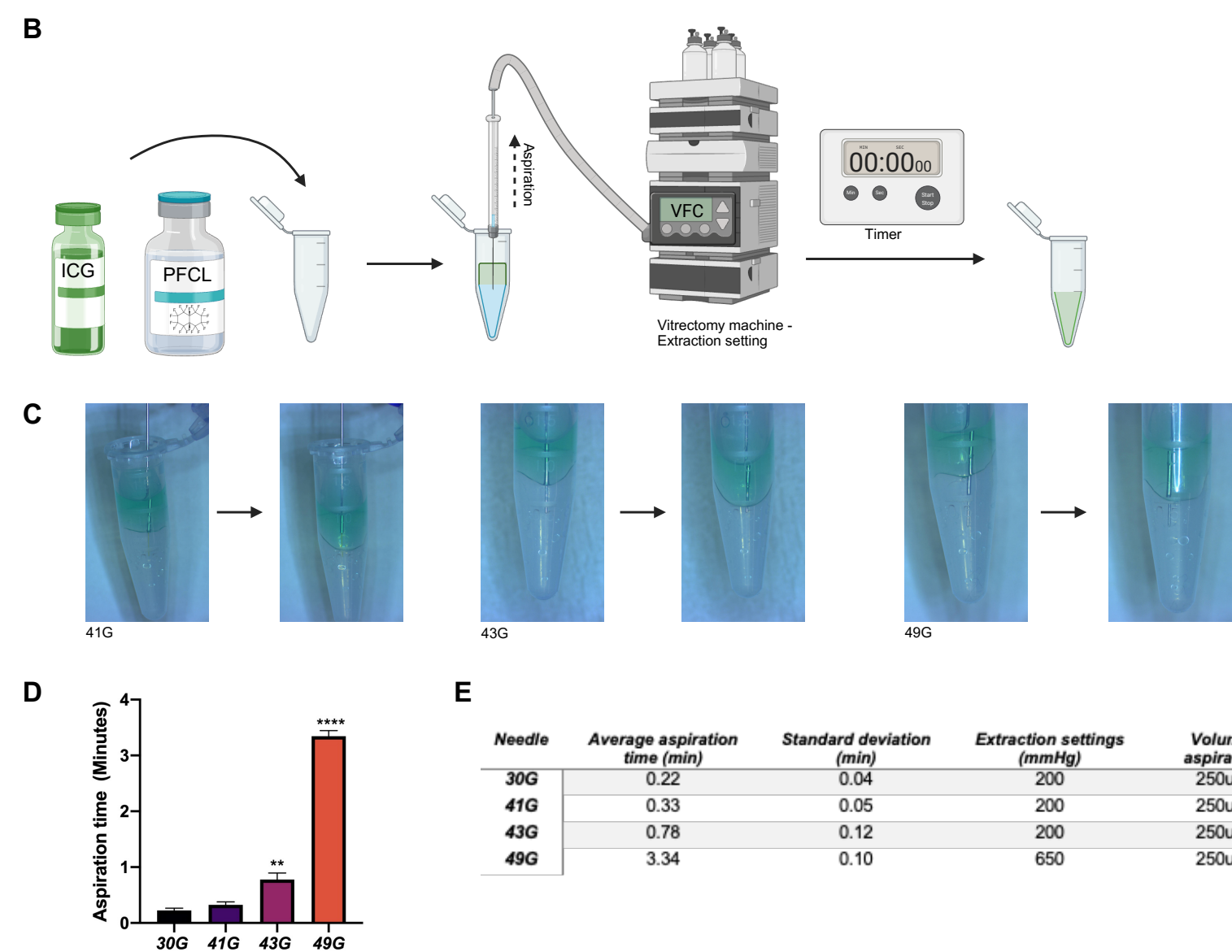


Fig. 1:In vitro aspiration of PFCL using microneedles attached to a vitrectomy machine. (B) A 5% ICG solution and PFCL is added to an Eppendorf before the microneedle is immersed in the PFCL and aspirated with various extraction settings and timed to remove 250μL. (C) Still images from video microscopy of PFCL extraction covered by a layer of 5% ICG-ddH₂O using 41G, 43G and 49G microneedles. (D) The average time to aspirate 250μL of PFCL is shown in the table with standard deviation (n=6) (E).

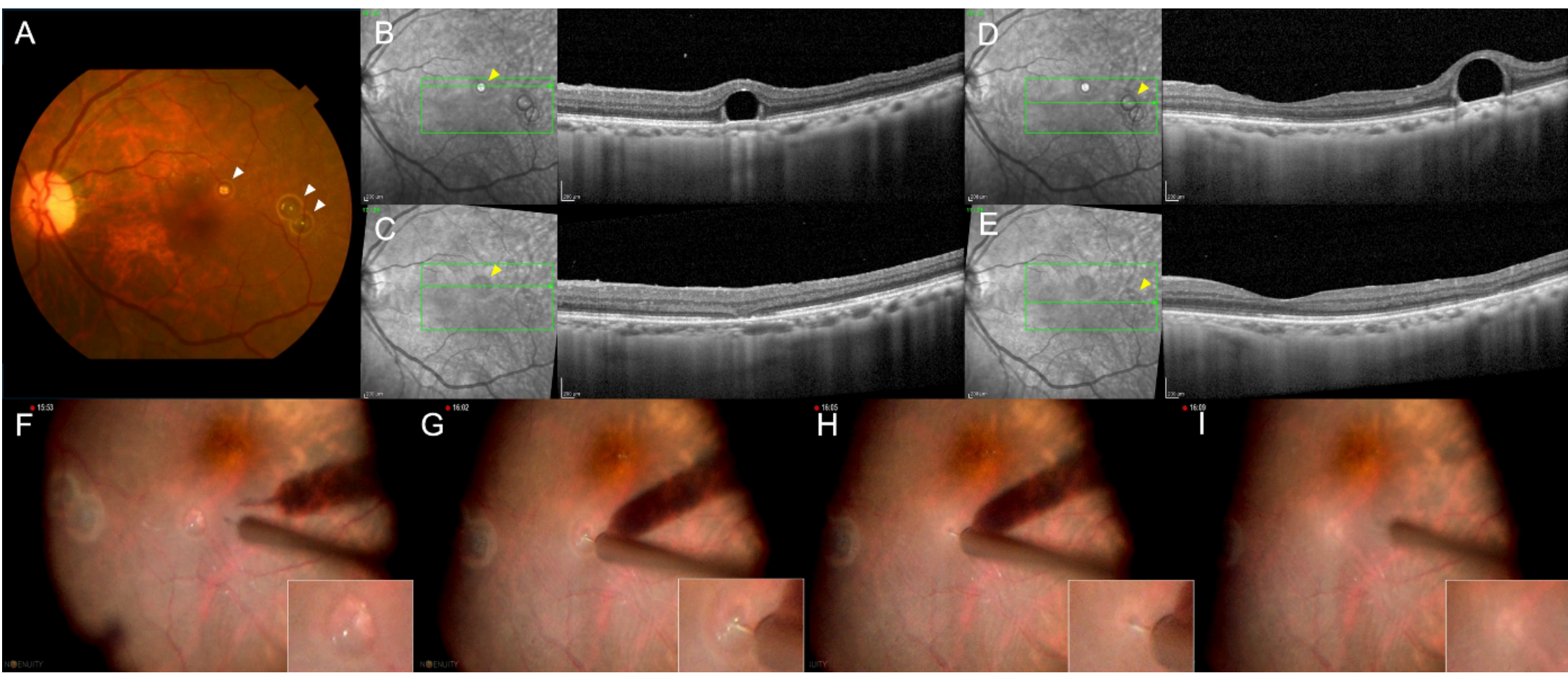


Fig. 3: In vivo subretinal PFCL aspiration. (A) The fundus photograph reveals three distinct retained PFCL droplets (white arrowheads). (B-D) Preoperative (B, D) and postoperative (C, E) infrared and SD-OCT images are shown. B corresponds to C, and D corresponds to E, with yellow arrowheads marking the same locations. SD-OCT confirms complete removal of PFCL, with no changes observed except for EZ irregularity caused by retained PFCL. (F-I) The series of surgical images includes an enlarged view of the PFCL droplet in the lower-right corner. The 49G microneedle is directed toward the center of the PFCL droplet (F, G). Once puncture is confirmed, suction is applied using active aspiration system (H). Successful aspiration of PFCL droplet is confirmed (I).

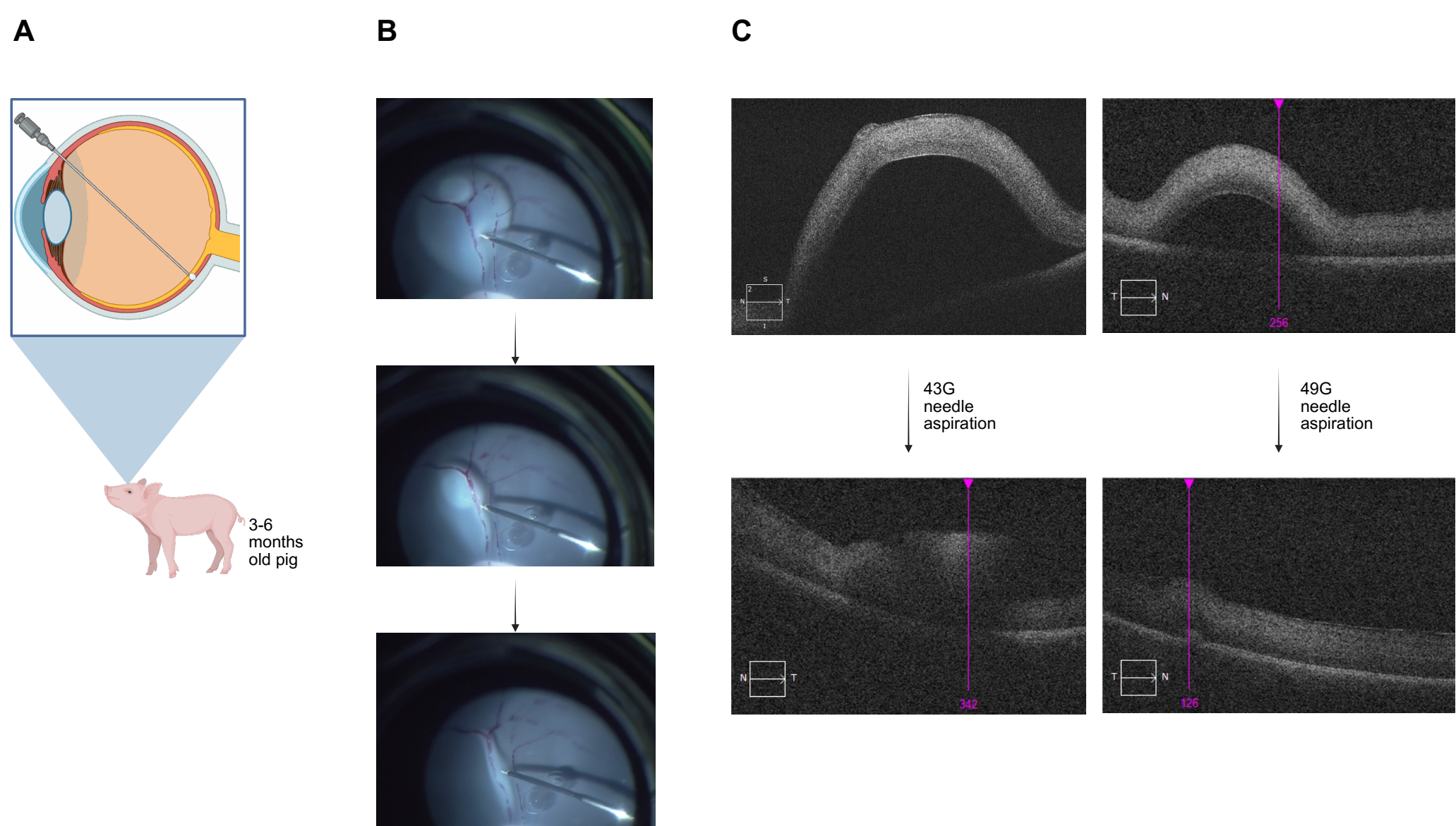


Fig. 2:Ex vivo porcine model of retained subretinal PFCL. (A) Schematic demonstrating 3-6 month old pig eye freshly harvested. (B) PFCL is injected into the subretinal space using a 41G cannula before being aspirated with microneedles. Intraoperative images showing the removal of subretinal PFCL in three still images starting at the first top image and ending at bottom third image. (C) SD-OCT images depicting subretinal PFCL before removal with a 43G microneedle (left images) and a 49G microneedle (right images).

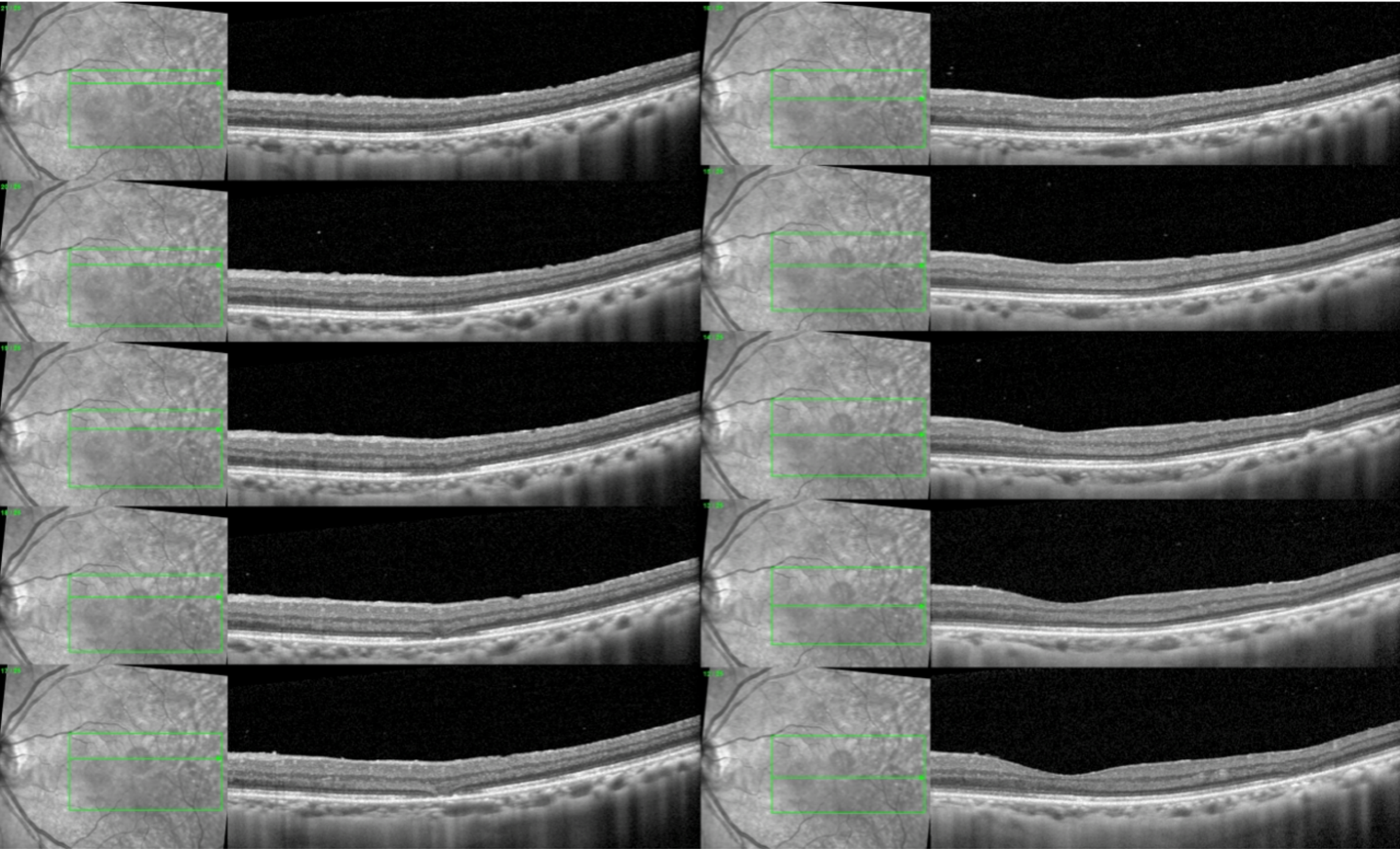


Fig. 4: SD-OCT volume scan showing all B-scans through the site of retained subretinal PFCL, showing no signs of a wound site or fibrotic change.

CONCLUSIONS

- Stainless steel microneedles provide a **safe, effective, minimally invasive** option for direct subretinal PFCL removal.
- Particularly valuable for **subfoveal or perifoveal retained PFCL**, where minimizing retinal trauma is critical.

Case	Age	Sex	Disease	Number of PFCL drops	Duration of PFCL (days)	Location of PFCL	Change VA (logMAR)
1	62	F	PDR	2	-	Parafoveal	-0.12
2	32	M	PVR RRD	5	28	Parafoveal	-0.20
3	78	M	PVR	5	28	Parafoveal	-0.02
4	53	F	PVR RRD	3	84	Parafoveal	0.00
5	56	F	GRT	1	7	Subfoveal	-0.20
6	61	M	RRD	1	4	Subfoveal	-0.19
7	53	M	RRD	1	7	Subfoveal	0.21
8	63	M	PVR RRD	2	14	Subfoveal	-0.10
9	63	M	PDR	2	21	Subfoveal	-0.10
10	45	F	PVR RRD	3	14	Subfoveal	-0.02

Table 1.: Characteristics of patients presenting with retained subretinal perfluorocarbon liquid following vitrectomy surgery.

Take home message

49G microneedle aspiration enables controlled PFCL removal with minimal retinal disruption and favorable early clinical outcomes.

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