CANNUSAFE™ · THE SCIENCE PATIENT SAFETY · SURGICAL MECHANICS

The science of cannula detachment — and why *eyes are in the firing line*

A Luer-lock connection is trusted across the whole of medicine. So why does it fail, repeatedly, in the operating theatre of the eye? The answer lies not in the surgeon's hands, but in the physics of the connection itself.

Based on a peer-reviewed mechanical analysis Amar Alwitry · FRCS FRCOphth MMedLaw

THE PUZZLE

A connection that works everywhere — except the eye

When a cannula detaches during intraocular surgery, the assumption is almost always the same: someone failed to tighten it. The event is logged as a surgical complication, and the surgeon carries the consequence. Yet the very same Luer-lock fitting is used safely, millions of times a day, for intravenous and spinal injections across medicine. Spontaneous disconnection under load is rare — almost unheard of — outside ophthalmology.

That contradiction is the starting point. If the connection is sound enough for the rest of the body, the explanation for its failure in the eye cannot simply be carelessness. It must be something about the conditions of eye surgery itself. A first-principles analysis of the forces at the connection reveals three mechanisms — each unremarkable on its own — that combine **only** in intraocular surgery to turn a reliable fitting into a hazard.

> *The cannula detaches not because the surgeon failed, but because the eye is the one place where the connection is asked*

> *to do the impossible.*

THREE MECHANISMS, ONE EYE

Why the connection gives way

01 The force comes from the syringe, not the cannula

It is natural to assume a finer cannula generates more force — it does not. The pressure driving the connection apart is fixed by how hard the plunger is pushed and how wide it is; the cannula plays no part in setting it. Crucially, **small syringes amplify that force dramatically**: a 1 ml syringe converts more than half of the applied thumb force into force trying to eject the cannula, while a 10 ml converts under 6%. The small syringes used for intraocular work sit at the most dangerous end of this range.

02 The fluids of surgery unlock the thread

A Luer lock holds only while friction in its thread resists the load. But the connection in eye surgery is continually bathed in balanced salt solution and viscoelastic — and **viscoelastic is one of nature's most effective lubricants**, the same family of molecule that lubricates our joints. As it coats the thread, friction falls below the point at which the lock can hold itself shut, and the injecting force no longer strains the joint but actively unscrews it. The fluid that makes the surgery possible is the fluid that defeats the lock. The clear prediction follows: **the more cohesive, higher-viscosity viscoelastics — those that lubricate best — carry the greatest detachment risk of all.**

03 The freed cannula meets tissue it cannot fail to damage

Once released, the cannula concentrates the injecting force onto a tip the width of a hair. The resulting contact stress is **one to two orders of magnitude beyond the strength of the tissues of the eye** — the lens capsule, retina, iris and cornea

alike. There is no force here that the eye can withstand: penetration of whatever the tip meets is, on the numbers, effectively certain.

>50%
of thumb force transmitted as ejecting force on a **1 ml syringe** – versus under 6% on a 10 ml

~20 N
ejecting force from a firm injection on a small syringe – enough to launch the cannula

100×
by which the cannula tip's contact stress can exceed the failure strength of ocular tissue

THE CRUX

Why the eye, and nowhere else

In most of medicine, a detached needle goes nowhere. It is buried in tissue – held along its length by skin and muscle, its tip embedded in flesh that arrests it. Even a joint injection sits deep within a sleeve of tissue that grips and restrains it. A connection that lets go is, almost always, an event of no consequence.

The eye is the exception. The cannula passes through a corneal wound that scarcely grips it, and its tip hangs free in the watery anterior chamber. **There is nothing to hold the shaft and nothing to stop the tip.** The same release that would be harmless in soft tissue becomes, in the open fluid-filled eye, the launch of a metal projectile across the most delicate structures in the body.

ANYWHERE ELSE IN THE BODY

Needle gripped along its shaft · tip embedded in tissue · a detached connection travels nowhere · the event is inconsequential.

IN THE EYE

Cannula suspended through a non-gripping wound · tip free in aqueous · nothing to restrain it ·

the connection releases and the cannula is launched.

WHAT IT MEANS

A device failure, not a human one

Put together, these mechanisms reframe cannula detachment entirely. The forces are highest exactly where the eye uses the smallest syringes; the lock is weakest exactly where surgical fluids flood it; and the freed cannula is least restrained exactly where the tissue is least able to survive it. Every factor peaks in the same place, in the same instant, in the same procedure.

This is not a lapse of surgical technique. It is a **predictable, foreseeable failure of a device interface** – one that has been quietly attributed to surgeons for decades because no single component ever "malfunctions," and so no alarm is ever raised. Recognising the true mechanism changes how the complication should be reported, where responsibility for it properly lies, and what an acceptable standard of care now requires.

IN ONE LINE

The connection isn't poorly made. It is being asked to work at the one corner of its envelope where its safety margin disappears.

Small syringes drive the force up; the fluids of surgery strip the lock's grip away; and a wound-suspended cannula in open aqueous has nothing to stop it. Only in the eye do all three coincide.

A DIRECT MESSAGE TO VISCOELASTIC MANUFACTURERS

Viscoelastics are the highest-risk step of all

The lubrication mechanism is not a side note — it is the single most eye-specific driver of detachment, and it points squarely at viscoelastic injection. The agents that perform best in the eye are precisely the ones that lubricate the lock most effectively, and the high resistance of a cohesive viscoelastic forces the surgeon to hold the connection at maximum pressure for the length of the injection. **Force at its peak, friction at its lowest — at the same moment, in the same hand.**

Viscoelastic and pack providers need to be alive to this. A delivery system supplied without a means of securing the cannula is, on this analysis, supplied with a foreseeable and now-documented failure mode built in. As awareness of the mechanism grows, so does the expectation that those who supply these systems address it.

THE SOLUTION

Cannusafe™ closes the one gap the Luer lock cannot

Cannusafe is a sterile, single-use device that adds an independent mechanical restraint at the syringe–cannula junction. It does not rely on the Luer thread — the very thing the science shows to be compromised. The cannula is threaded through a central aperture and the adhesive arms are pressed to the barrel, so that **even if the**

Luer lock fully unscrews, the cannula is mechanically arrested and cannot enter the eye. It directly defeats every one of the three mechanisms described above.

> *It removes the failure mode entirely: the lock can lubricate open, the force can peak — and the cannula still cannot reach the eye.*

DEFEATS MECHANISM 1 — THE FORCE

Independent of syringe size

The mechanical arrest works the same whether the force comes from a 1 ml or a 10 ml syringe. The amplification that makes small syringes dangerous is made irrelevant.

DEFEATS MECHANISM 2 — THE LUBRICATION

Does not depend on the thread

Cannusafe restrains the cannula independently of the Luer lock. It does not matter that viscoelastic has lubricated the thread open — the cannula is held regardless.

DEFEATS MECHANISM 3 — THE PROJECTILE

The tip never reaches tissue

By arresting the cannula at the junction, Cannusafe ensures the tip never becomes a free projectile in the anterior chamber. The stresses that would destroy tissue are never delivered.

UNIVERSAL & FRICTIONLESS

Every syringe, every procedure

One device fits 1, 2, 3 and 5 ml syringes — protecting every junction in the case, not one. Applied by the scrub practitioner in about a second, with no change to the surgeon's workflow.

Where a viscoelastic screw cap protects only its own syringe and leaves every other junction in the procedure exposed, ***Cannusafe*** protects them all — including the highest-risk viscoelastic step. It is the only device that prevents cannula detachment across every syringe size used in intraocular surgery, while carrying an integrated labelling surface for mandatory syringe identification. Manufactured to EU MDR standards by a specialist European manufacturer, Cannusafe will be fully CE certified ahead of its commercial release.

PREVENT THE PREVENTABLE

The mechanism is now understood. So is the solution.

For commercial, distribution and clinical enquiries, or to discuss incorporating Cannusafe into your procedure packs, we would welcome the conversation.

CONTACT CANNUSAFE

INTERNATIONAL PATENT WO2025/163287A1 GRANTED · FDA CLASS I EXEMPT · FULL CE CERTIFICATION IN PLACE AHEAD OF COMMERCIAL RELEASE · INTERNATIONAL TRADEMARK REGISTERED

THE PUBLISHED EVIDENCE BASE

Alwitry A. Cannula detachment — a solution to a significant patient safety and health economic issue. *Eye (Lond)*. 2026;40:1097–1098.

Alwitry A. The endemic avoidable harm of cannula dislodgement. *Eye (Lond)*. 2026;40(2):275.

Alwitry A. Prevalence of cannula dislocation during cataract surgery: a survey. *J Cataract Refract Surg*. 2025;51(11):1034–1036.

Mechanical analysis of the syringe–cannula interface — manuscript under consideration, *Eye (Lond)*.

This page summarises a peer-reviewed mechanical analysis of why the syringe–cannula connection fails in intraocular surgery, and applies its findings to the Cannusafe™ device. The mechanical analysis describes the physics of the failure mode and does not constitute clinical or engineering advice; figures are illustrative orders of magnitude derived from a first-principles analysis with stated assumptions. Cannusafe™ is protected by granted International Patent WO2025/163287A1 and is FDA Class I exempt. It is manufactured to EU MDR standards by a specialist European manufacturer and will be fully CE certified ahead of commercial release.