Gas plasma ion surface modification of nanostructured poly-L-lactide-co-ε-caprolactone implants for pelvic organ prolapse.

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BACKGROUND

- **Poly-L-lactide-co-ε-caprolactone (PLCL)** vaginal implants are biocompatible grafts that are well-matched to the elastic modulus of vaginal extra-cellular matrix (ECM), with promising applications in surgery for pelvic organ prolapse (POP) [1].
- **Gas plasma ion surface modification** is an emerging technology that converts organic allyamine monomers to reactive polymer thin films (100Å–1 µm) that can be deposited on biomaterials, to modify their surface [2].
- This technique has demonstrated improvements in the **physicochemical behaviour**, **structural properties** and **tissue interaction** of next generation biomaterials, enhancing their biocompatibility and improving the foreign body response [3].

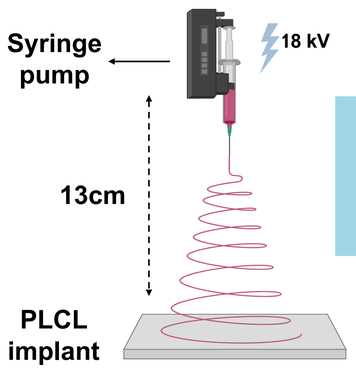
AIMS

- To assess the effect of **gas plasma ion surface modification** on tissue integration, tensile characteristics and foreign body response of **degradable PLCL** vaginal implants in an **ovine pre-clinical model** of female pelvic floor reconstruction.

METHODS

Nanofabrication

Electrospinning of PLCL polymer in HFP solvent (10%w/w)

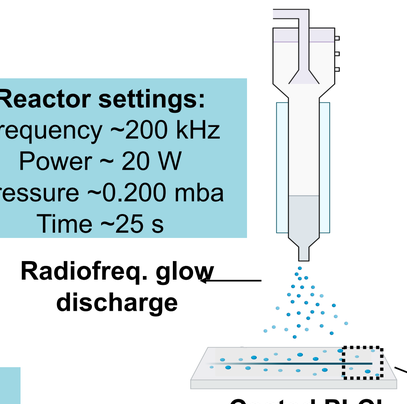


Implant dimensions ~3x2 cm
Fiber diameter ~600 nm
Pore size ~1.5 µm

Plasma Polymerization

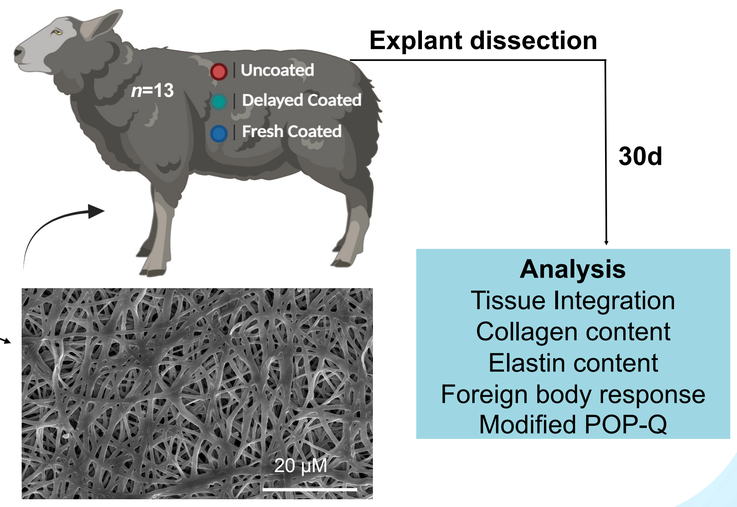
Surface deposition of ultrathin layer of allylamine deposited (Aldrich, 98% purity)

Reactor settings:
Frequency ~200 kHz
Power ~ 20 W
Pressure ~0.200 mba
Time ~25 s



Large Animal Surgery

Multiparous ewes (*n*=13) with **vaginal wall weakness** underwent PLCL-augmented posterior colporrhaphy across 3 groups: **freshly coated** PLCL (*n*=5), **delayed coated** PLCL (coating with implant delay of 30 days) (*n*=4), and **uncoated** PLCL implants (*n*=4)



Analysis
Tissue Integration
Collagen content
Elastin content
Foreign body response
Modified POP-Q

RESULTS

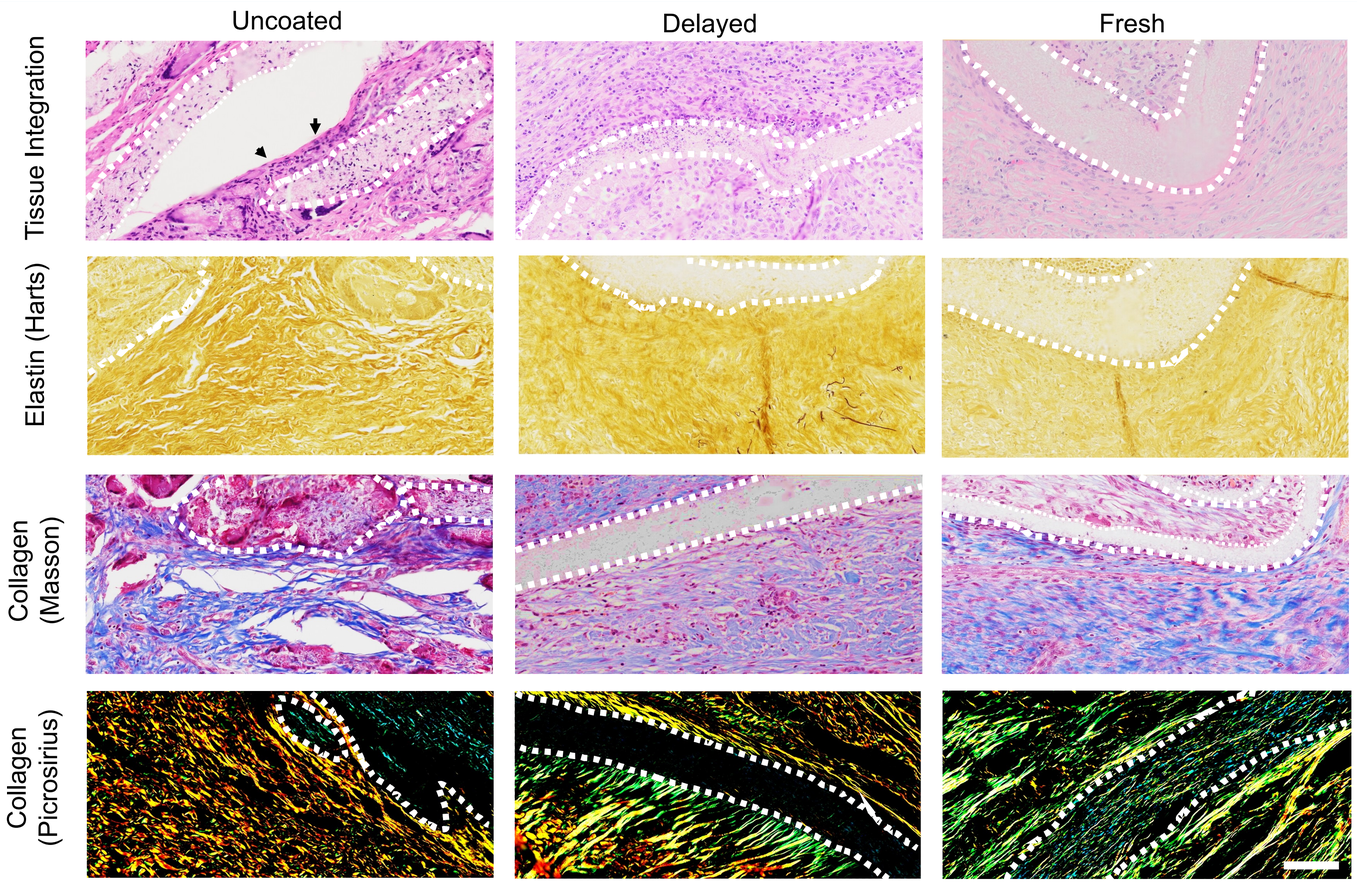


Figure 1: *Effect of PLCL gas plasma ion coating on tissue integration, cell infiltration, elastin and collagen (Masson's trichome & Picosirus) metabolism surrounding PLCL vaginal implants. Scalebar = 50µm.*

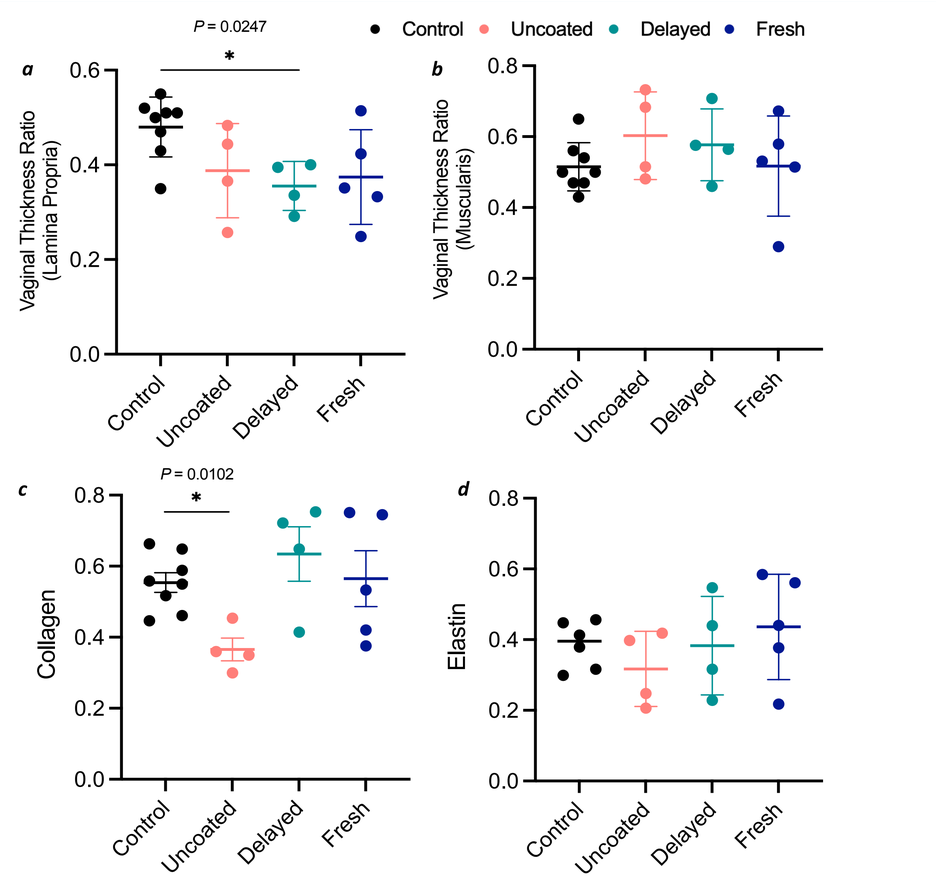


Figure 2: *Effect of PLCL gas plasma ion coating on vaginal tissue thickness (a,b), total (masson's) collagen content (c), and elastin content (d) when compared with non-operative control (* = P <0.05).*

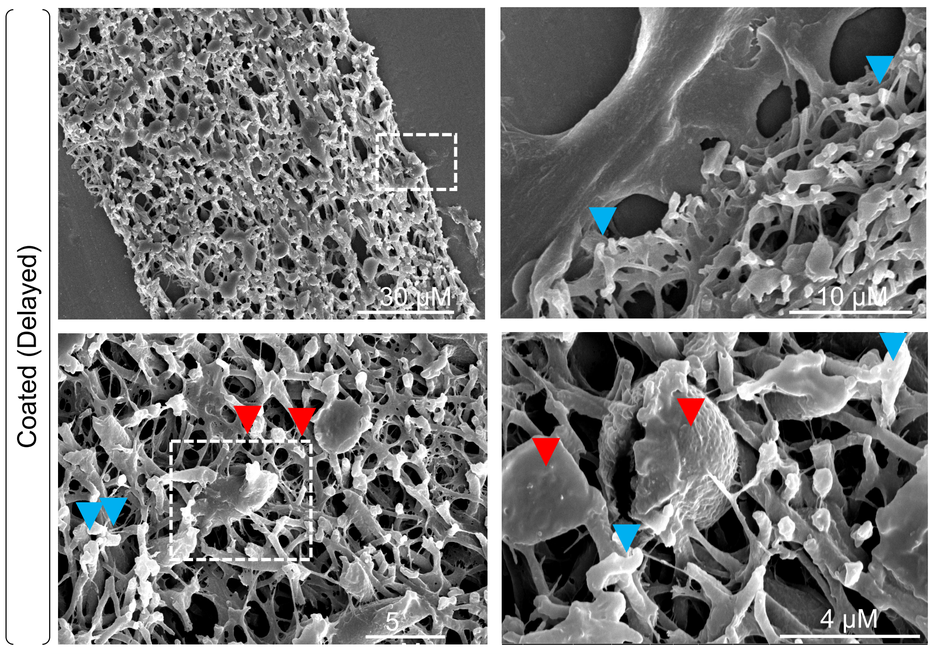


Figure 3: *In-vivo SEM images of plasma ion surface modified PLCL demonstrating good mesh-tissue integration (blue arrowheads), low power (left), high power (right).*

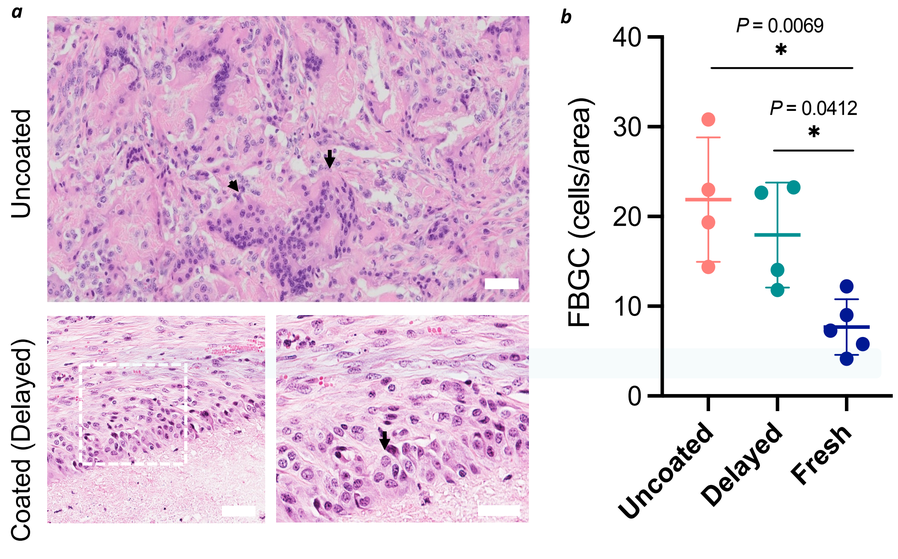


Figure 4: *Foreign body giant cell morphology (a) and quantification (b) in coated and uncoated PLCL implants (* = P <0.05). Scalebar = 50 µm, 2µm.*

CONCLUSION

- Our study highlights that **gas plasma ion surface modification** of PLCL significantly improves improves **host vaginal tissue integration, collagen and elastin metabolism, and implant foreign body response.**
- This emerging technology has a huge potential in the generation of highly **compatible bioengineered surgical constructs** for pelvic floor reconstruction and other surgical applications.

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