EP-122

젠타마이신 탑재 3D 프린팅 돼지 유래 ECM 지지체의 개발 및 체외 생체적합성 평가

(Development of a Gentamicin-Loaded 3D-Printed Porcine ECM Scaffold and Its In Vitro Biocompatibility)

아주대학교 의과대학 성형외과학교실

김민지, **김형기**, 홍승희, 한은희, 임수진, 이일재*

PURPOSE

- **Infected soft tissue defects** are a major challenge in reconstructive surgery.
- The ideal implantable material should support **both tissue regeneration and local infection control**.
- We developed a **gentamicin-loaded 3D-printed porcine ECM scaffold** and evaluated its in vitro biocompatibility.

METHODS

- Porcine type I collagen scaffolds fabricated by extrusion-based 3D bioprinting with chemical (EDC/NHS) or physical (dehydrothermal) crosslinking.
- Gentamicin sulfate loaded via controlled immersion in 2.0% solution.
- L929 mouse fibroblasts seeded; cell adhesion, activity, proliferation, and infiltration evaluated.
- Six experimental groups (Fig. 1):

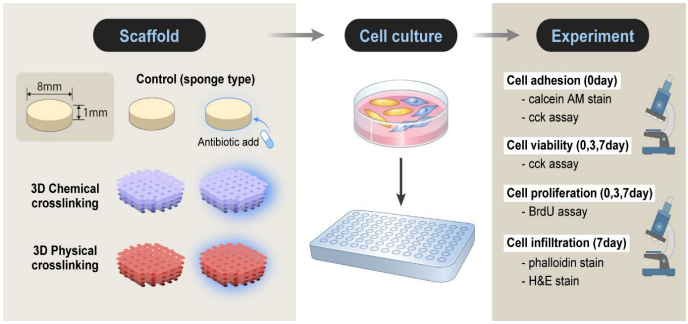
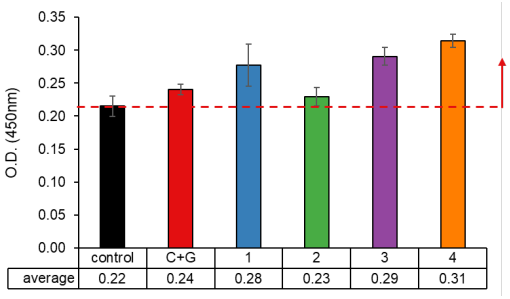


Fig. 1. Schematic of study design and six experimental groups.

RESULTS

Cell Adhesion

- Cell adhesion was **significantly enhanced in all 3D-printed groups** vs. control (C+G: 1.12×, 3D-Chem: 1.29×, 3D-Chem+G: 1.07×, 3D-Phys: 1.35×, 3D-Phys+G: **1.46×**).
- In physically crosslinked scaffolds, adhesion **remained stable** despite antibiotic presence.

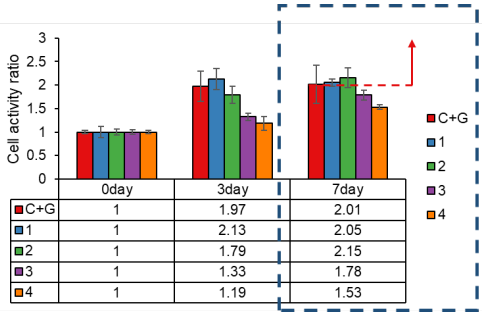


	control	C+G	1	2	3	4
average	0.22	0.24	0.28	0.23	0.29	0.31

Fig. 2. Cell adhesion (CCK-8 assay, OD 450 nm).

Cell Activity

- Cell viability was **higher in chemically crosslinked groups** than physically crosslinked ones (vs. C+G: 3D-Chem **1.02×**, 3D-Chem+G **1.07×**; 3D-Phys 0.89×, 3D-Phys+G 0.76×).
- Chemical crosslinking maintained **higher viability even with antibiotics**.

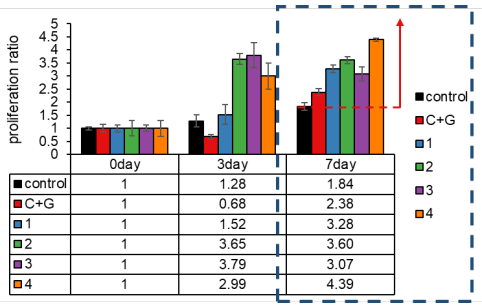


	0day	3day	7day
C+G	1	1.97	2.01
1	1	2.13	2.05
2	1	1.79	2.15
3	1	1.33	1.78
4	1	1.19	1.53

Fig. 3. Cell activity at days 0, 3, 7 (CCK-8 assay).

Cell Proliferation

- Both crosslinking methods showed **significantly enhanced proliferation** vs. C+G (3D-Chem: 1.38×, 3D-Chem+G: 1.51×, 3D-Phys: 1.29×, 3D-Phys+G: **1.84×**).
- Regardless of crosslinking method, **antibiotic-containing groups showed higher proliferation**.

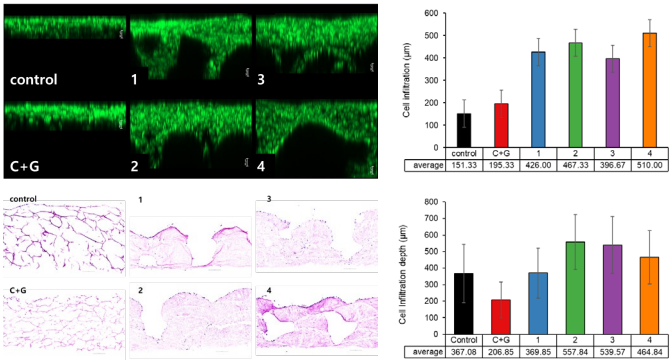


	0day	3day	7day
control	1	1.28	1.84
C+G	1	0.68	2.38
1	1	1.52	3.28
2	1	3.65	3.60
3	1	3.79	3.07
4	1	2.99	4.39

Fig. 4. Cell proliferation at days 0, 3, 7 (BrdU assay).

Cell Infiltration

- 3D-printed groups showed **more effective cell infiltration** than sponge control (Phalloidin up to **3.37×**; H&E up to **1.52×**).
- Cell distribution **varied with pore architecture** of the scaffold.



	control	C+G	1	2	3	4
average	151.33	195.33	426.00	467.33	396.67	510.00

	Control	C+G	1	2	3	4
average	367.08	206.85	369.85	557.84	539.57	464.84

Fig. 5. Cell infiltration at day 7: (A) phalloidin z-stack images, (B) infiltration depth by z-stack, (C) H&E histology, (D) infiltration depth by H&E (μm).

CONCLUSION

- The **gentamicin-loaded 3D-printed porcine ECM scaffold** exhibited excellent in vitro biocompatibility and maintained antibacterial activity.
- **Chemical crosslinking** was identified as the **optimal manufacturing method**.
- Findings support clinical potential as an **implantable biomaterial** for infected soft tissue defects.