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Christel Henrionnet, Océane Messaoudi, Laurent Grossin, Didier Mainard, Laurent Galois, et al.. Interest of type I collagen as an additive in an alginate-based bioink for the production of stratified cartilaginous substitutes by using 3D printing. 23èmes Journées Françaises de Biologie des Tissus Minéralisés, May 2023, Sète, France. hal-04120398

HAL Id: hal-04120398

<https://hal.science/hal-04120398v1>

Submitted on 7 Jun 2023

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Interest of type I collagen as an additive in an alginate-based bioink for the production of stratified cartilaginous substitutes by using 3D printing

Christel HENRIONNET¹, Océane MESSAOUDI¹, Laurent GROSSIN¹, Didier MAINARD^{1,2}, Laurent GALOIS^{1,2}, Damien LOEUILLE^{1,3}, Christophe MARQUETTE⁴, Pierre GILLET¹ and Astrid PINZANO¹

1 : UMR7365 CNRS-UL IMoPA, Vandœuvre-lès-Nancy, France ; 2 : Service de Chirurgie Orthopédique, Traumatologique et Arthroscopique (COTA), CHRU de Nancy, Nancy, France ; 3 : Service de Rhumatologie, CHRU de Nancy, Vandœuvre-Lès-Nancy, France ; 4 : Plateforme 3d.FAB, Université de Lyon, Villeurbanne, France

Introduction

Hyaline cartilage

Stratified
Non vascularized
Non innervated

→ Limited self-repair properties

Trauma or overload

Focal lesions

No long-term surgical solution

Objectives

Mesenchymal stem cells + Alginate-based ink → Bioink

Extrusion-based 3D printing method

In vitro production of stratified cartilaginous substitutes

Methods

Cellularized bioink

Addition of Type I collagen (0, 0.5, 1 or 5 mg)

To modulate the chondrogenic differentiation of MSCs

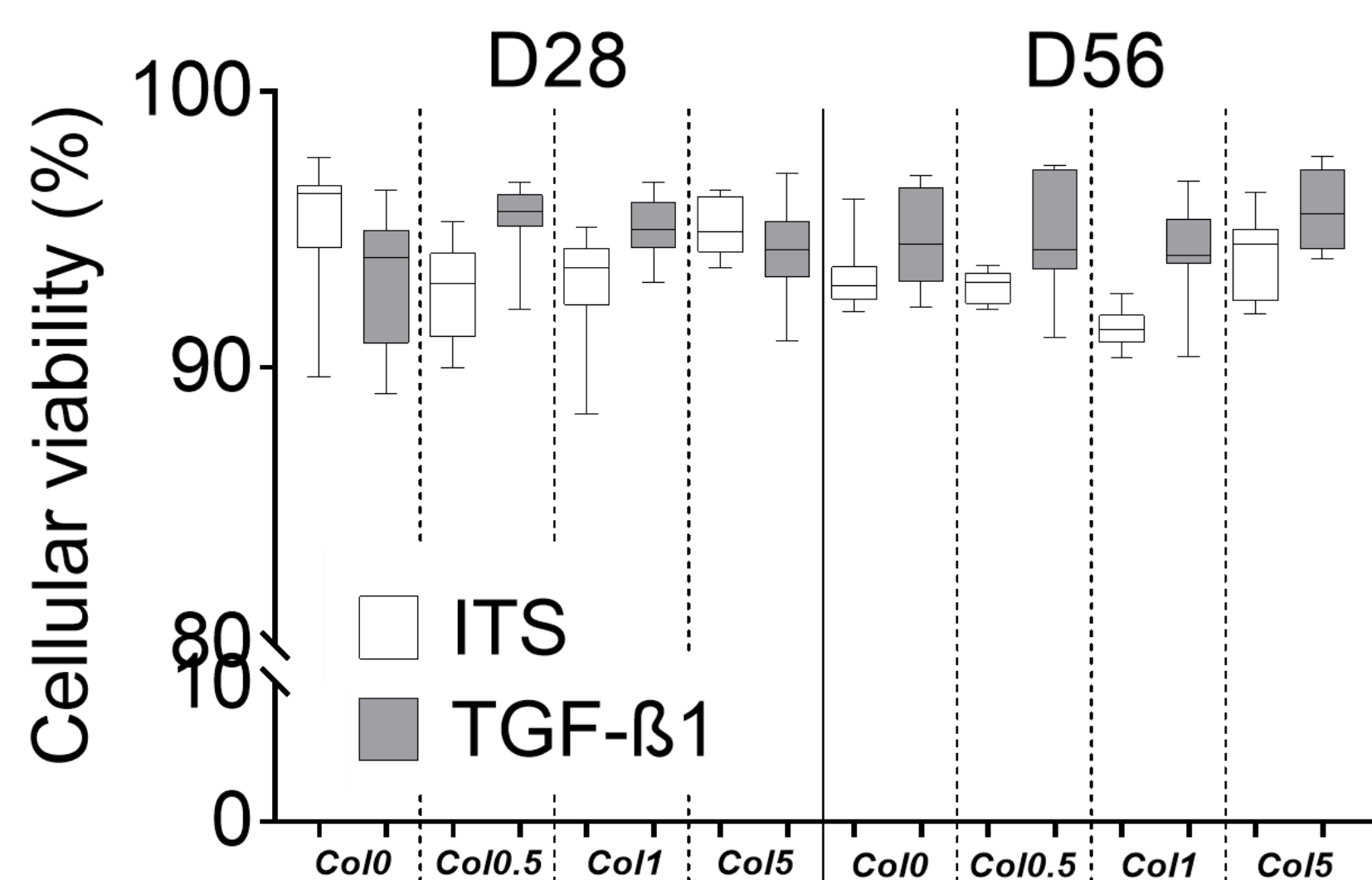
Culture conditions (56 days):
ITS 1%: Control
TGF-β1: Chondro-inductor

Analyses :

Cellular viability : LDH assay
Genes expressions : RT-qPCR
Matrix synthesis : Histological and immunohistochemical analyses

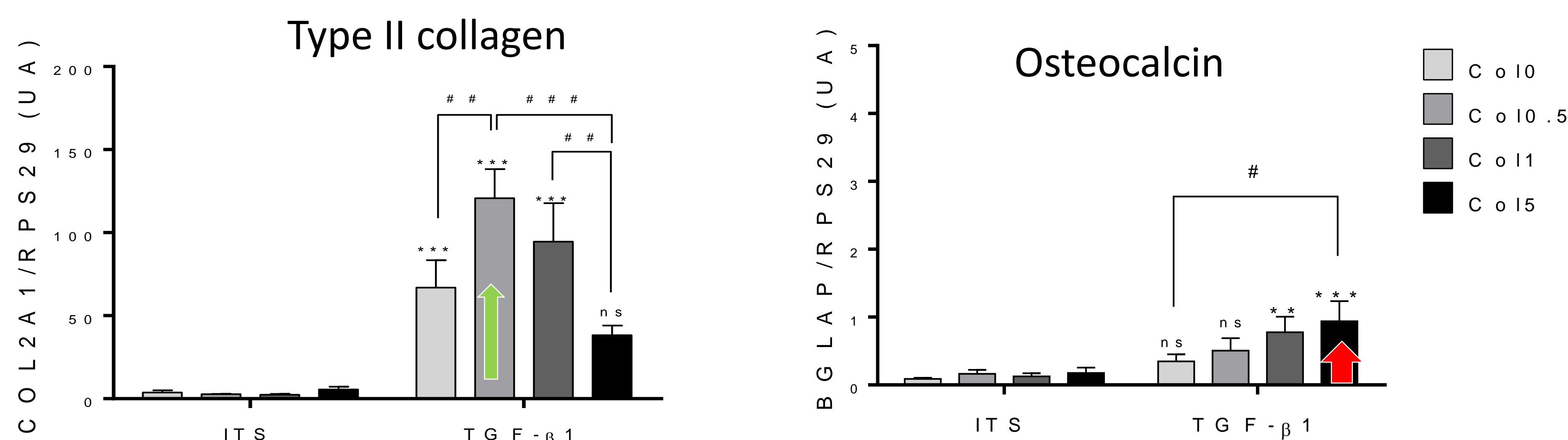
Results

1. Viability assay (LDH)

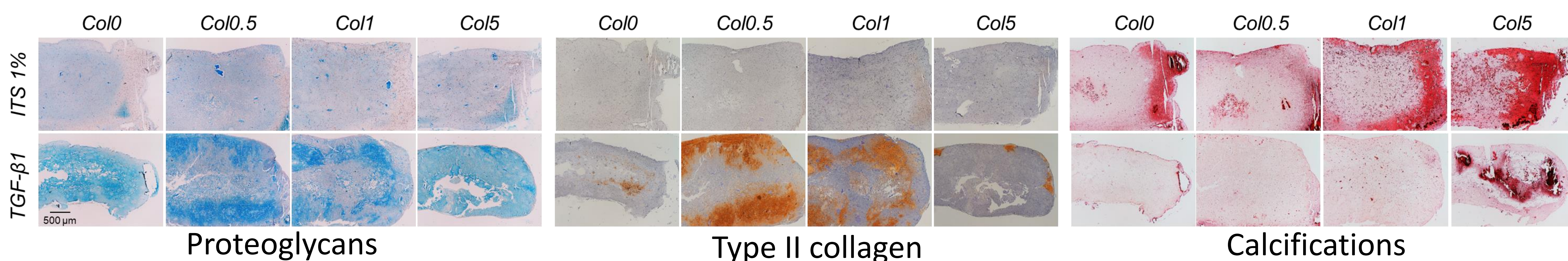


Mean ± SEM. Effect of TGF-β1: * p < 0.05, ** p < 0.01, and *** p < 0.001. Effect of the bioink composition : § p < 0.05, §§ p < 0.01, and §§§ p < 0.001. ; ns: not significant.

2. Gene expressions of chondrogenic and osteogenic markers (Day 28)



3. Matrix synthesis analyses: Proteoglycans, type II collagen and alizarin red (Day 56)



Conclusions

Low type I collagen addition (0.5 mg) :

- Proteoglycans
- Type II collagen
- Calcifications

➔ Rich matrix adapted to recreate the superficial layers of the cartilage

High type I collagen addition (5 mg) :

- Proteoglycans
- Type II collagen
- Calcifications

➔ Calcified matrix mimicking the calcified layer of the cartilage

Perspectives

Autologous and personalized regenerative medicine