ML37-20 (05/10/2020)

Bioact Mater

. 2020 Sep 19;6(3):613-626.
doi: 10.1016/j.bioactmat.2020.08.035. eCollection 2021 Mar.

Development of methods for detecting the fate of mesenchymal stem cells regulated by bone bioactive materials

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- PMID: 33005826

- PMCID: PMC7508719

- DOI: 10.1016/j.bioactmat.2020.08.035

Free PMC article

Abstract

The fate of mesenchymal stem cells (MSCs) is regulated by biological, physical and chemical signals. Developments in biotechnology and materials science promoted the occurrence of bioactive materials which can provide physical and chemical signals for MSCs to regulate their fate. In order to design and synthesize materials that can precisely regulate the fate of MSCs, the relationship between the properties of materials and the fate of mesenchymal stem cells need to be clarified, in which the detection of the fate of mesenchymal stem cells plays an important role. In the past 30 years, a series of detection technologies have been developed to detect the fate of MSCs regulated by bioactive materials, among which high-throughput technology has shown great advantages due to its ability to detect large amounts of data at one time. In this review, the latest research progresses of detecting the fate of MSCs regulated by bone bioactive materials (BBMs) are systematically reviewed from traditional technology to high-throughput technology which is emphasized especially. Moreover, current problems and the future development direction of detection technologies of the MSCs fate regulated by BBMs are prospected.

The aim of this review is to provide a detection technical framework for researchers to establish the relationship between the properties of BMMs and the fate of MSCs, so as to help researchers to design and synthesize BBMs better which can precisely regulate the fate of MSCs.

J Clin Orthop Trauma
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. 2020 Oct;11(Suppl 5):S789-S794.
doi: 10.1016/j.jcot.2020.07.003. Epub 2020 Jul 19.

Bone marrow aspirate clot: A feasible orthobiologic

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- PMID: 32999557

- PMCID: PMC7503156 (available on 2021-10-01)

- DOI: 10.1016/j.jcot.2020.07.003

Abstract

Musculoskeletal disorders are one of the major health burdens and a leading source of disability worldwide, affecting both juvenile and elderly populations either as a consequence of ageing or extrinsic factors such as physical injuries. This condition often involves a group of locomotor structures such as the bones, joints and muscles and may therefore cause significant economic and emotional impact. Some pharmacological and non-pharmacological treatments have been considered as potential solutions, however, these alternatives have provided quite limited efficacy due to the short-term effect on pain management and inability to restore damaged tissue. The emergence of novel therapeutic alternatives such as the application of orthobiologics, particularly bone marrow aspirate (BMA) clot, have bestowed medical experts with considerable optimism as evidenced by the significant results found in numerous studies addressed in this manuscript. Although other products have been proposed for the treatment of musculoskeletal injuries, the peculiar interest in BMA, fibrin clot and associated fibrinolytic mechanisms continues to expand. BMA is a rich source of various cellular and molecular components which have demonstrated positive effects on tissue regeneration in many *in vitro* and *in vivo* models of

musculoskeletal injuries. In addition to being able to undergo self-renewal and differentiation, the hematopoietic and mesenchymal stem cells present in this orthobiologic elicit key immunomodulatory and paracrine roles in inflammatory responses in tissue injury and drive the coagulation cascade towards tissue repair via different mechanisms. Although promising, these complex regenerative mechanisms have not yet been fully elucidated.

Microorganisms
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. 2020 Sep 26;8(10):E1478.
doi: 10.3390/microorganisms8101478.

Canine Bone Marrow Mesenchymal Stem Cell Conditioned Media Affect Bacterial Growth, Biofilm-Associated *Staphylococcus aureus* and AHL-Dependent Quorum Sensing

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- PMID: 32993120

- DOI: 10.3390/microorganisms8101478

Free article

Abstract

The present study investigated the in vitro antibacterial, antibiofilm and anti-Quorum Sensing (anti-QS) activities of canine bone marrow mesenchymal stem cell-conditioned media (cBM MSC CM) containing all secreted factors <30 K, using a disc diffusion test (DDT), spectrophotometric Crystal Violet Assay (SCVA) and Bioluminescence Assay (BA) with QS-reporter *Escherichia coli* JM109 pSB1142. The results show a sample-specific bacterial growth inhibition (zones varied between 7-30 mm), statistically significant modulation of biofilm-associated *Staphylococcus aureus* and *Escherichia coli* bioluminescence (0.391 ± 0.062 in the positive control to the lowest 0.150 ± 0.096 in the experimental group, cf. 11,714 ± 1362 to 7753 ± 700, given as average values of

absorbance A_{550} ± SD versus average values of relative light units to growth RLU/A_{550} ± SD). The proteomic analysis performed in our previous experiment revealed the presence of several substances with documented antibacterial, antibiofilm and immunomodulatory properties (namely, apolipoprotein B and D; amyloid-β peptide; cathepsin B; protein S100-A4, galectin 3, *CLEC3A*, granulin, transferrin). This study highlights that cBM MSC CM may represent an important new approach to managing biofilm-associated and QS signal molecule-dependent bacterial infections. To the best of our knowledge, there is no previous documentation of canine BM MSC CM associated with in vitro antibiofilm and anti-QS activity.

Materials (Basel)

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2020 Sep 25;13(19):E4290.
doi: 10.3390/ma13194290.

Customizable 3D-Printed (Co-)Cultivation Systems for In Vitro Study of Angiogenesis

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- PMID: 32992945

- DOI: 10.3390/ma13194290

Free article

Abstract

Due to the ever-increasing resolution of 3D printing technology, additive manufacturing is now even used to produce complex devices for laboratory applications. Personalized experimental devices or entire cultivation systems of almost unlimited complexity can potentially be manufactured within hours from start to finish-an enormous potential for experimental parallelization in a highly controllable environment. This study presents customized 3D-printed co-cultivation systems, which qualify for angiogenesis studies. In these systems, endothelial and mesenchymal stem cells (AD-MSC) were indirectly co-cultivated-that is, both cell types were physically separated through a rigid, 3D-printed barrier in the middle, while still sharing the same cell culture medium that allows for the exchange of signalling molecules. Biochemical-based cytotoxicity assays initially confirmed

that the 3D printing material does not exert any negative effects on cells. Since the material also enables phase contrast and fluorescence microscopy, the behaviour of cells could be observed over the entire cultivation via both. Microscopic observations and subsequent quantitative analysis revealed that endothelial cells form tubular-like structures as angiogenic feature when indirectly co-cultured alongside AD-MSCs in the 3D-printed co-cultivation system. In addition, further 3D-printed devices are also introduced that address different issues and aspire to help in varying experimental setups. Our results mark an important step forward for the integration of customized 3D-printed systems as self-contained test systems or equipment in biomedical applications.