Characterization of the immunomodulatory properties of graphene-based materials and their application as novel biomedical nanotools

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Abstract

Graphene-based materials (GBMs) are promising nanotools for biomedical application. However, a critical step for any clinical translation of GBMs is represented by the assessment of their impact on the complexity of the immune system.

Encouraged by our previous findings, demonstrating the dramatic impact exerted by the different physicochemical properties of GBMs on the modulation of their immune effects [1-4], here we evaluated the effects of graphene oxide (GO) and amino-functionalized GOs with different lateral size dimensions on a large variety of human immune cells (unpublished data).

Exploiting innovative approaches, such as single-cell mass cytometry, we revealed that the amino decoration of GO increased its immune compatibility and was also able to induce a specific M1 like activation of monocytes and the secretion of interleukin-4 and Granzyme-B from B cells, skewing a cytotoxic-like response.

Moreover, thanks to the combination of GO with inorganic quantum dots containing indium, the detection of GO cell uptake was enabled using single cell mass cytometry. Our results highlighted that monocytes and, intriguingly, B cells, were the main immune cell subpopulations able to internalize GO.

We finally exploited the immune modulatory proprieties of a specific GO on monocytes in combination with the osteoinductive capacity of calcium phosphates (CaP) for the design of a novel biocompatible nanomaterial called maGO-CaP (monocytes activator GO complexed with CaP) [5]. Our *in vitro* and *in vivo* results demonstrated maGO-CaP ability to induce osteoinductive stimuli increasing bone regeneration thanks to its modulation of the immune cell functionality.

Overall, our investigations suggest that well designed and functionalized GBMs allow the modulation of immune cells exploitable for the treatment of several pathologies, paving the way for their future biomedical applications.

References

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Figures

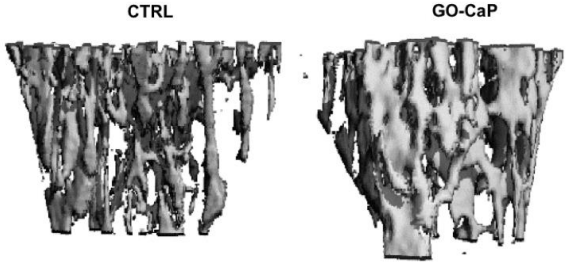

Figure 1. In vivo bone formation. Microcomputed tomography (µCT) image of untreated tibia (left, CTRL) and after one month of maGO-CaP treatment (right, GO-CaP).