Background: Rheumatoid arthritis (RA) is an autoimmune disorder that results in synovitis and joint destruction [1]. Macrophages, one of the various inflammatory cells, particularly infiltrate the RA synovial tissue and cause sustained inflammation that promote RA. And also the balance of pro-inflammatory M1 macrophages and anti-inflammatory M2 macrophages in RA joints is affected by overexpressed reactive oxygen species (ROS) and hypoxia synovium, which provides potential targets for the RA treatment.

Objectives: With the aim of alleviating the synovial inflammation in RA and restoring the balance of macrophage subtypes, we develop a catalytic nanoparticle named Ru@TiO2 which can produce O2 and scavenge ROS to reduce M1 macrophages, switch M1 phenotype to M2 phenotype.

Methods: Ru@TiO2 was synthesized using the hydrothermal method. The morphology and nanoparticle size were observed using the transmission electron microscopy (TEM). The catalytic ROS scavenging activities and O2 generation ability were examined through •O2• scavenging, H2O2 catalytic elimination and O2 generation assays. For in vitro experiment, the cytotoxicity of Ru@TiO2 conducted on RAW 264.7 cells was assessed by flow cytometry. To verify M1 to M2 macrophage phenotype transition and hypoxia alleviation, M1 and M2 markers and HIF-1α expression levels were evaluated by using qRT-PCR and Western Blot, respectively. In vivo, anti-inflammatory efficacy was observed after intra-joint injection of Ru@TiO2 into collagen-induced arthritis mouse. The clinical scores and paw thickness for the inflamed joints with different treatments at various time points were recorded. Ultrasound (US) was used to assess the inflamed joints after treatment and RNA expression levels of M1 and M2 macrophage markers in synovial tissue were evaluated through qRT-PCR. The statistical significance among multiple groups was examined by using one-way ANOVA.

Results: The Ru@TiO2 were fusiform in shape with an average size of 67 nm. The evaluation of catalytic ROS scavenging activities and O2 generation performance of Ru@TiO2 showed that Ru@TiO2 can achieve about 60% scavenging ratio to •O2• and about 80% producing ratio to O2 at 30 min. Ru@TiO2 also showed significantly increased H2O2 eliminating activity compared to the TiO2. In vitro, low cytotoxicity of Ru@TiO2 was displayed and the decrease of intracellular ROS level was most significant with Ru@TiO2. In addition, M1 macrophage markers (TNF-α and IL-1β) and HIF-1α expression levels were most prominently declined with Ru@TiO2. And the increase of M2 macrophage markers (Arg-1 and CD206) was most obvious when using Ru@TiO2. In vivo, the arthritis scores, paw thickness and thickness of articular cavity assessed by US in Ru@TiO2 group were the lowest when compared with other treated groups. Moreover, RNA expression levels of M1 and M2 macrophage markers in synovial tissue showed the similar tendency as in vitro.

Conclusion: In this study, the Ru@TiO2 was successfully synthesized with efficient catalytic ROS scavenging activities and O2 generation ability for the treatment of RA. In vitro, Ru@TiO2 shows good cell biocompatibility and effective intracellular ROS scavenging ability. Moreover, Ru@TiO2 alleviate the hypoxia condition in cells by producing O2. Furthermore, the significant and efficient polarization of M1 to M2 macrophages and suppression of inflammation were achieved both in vitro and in vivo through the treatment of Ru@TiO2 which indicated the therapeutic potential of Ru@TiO2 for RA therapy.


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functions. The "classically activated macrophage phenotype" is considered to be pro-inflammatory and contribute to RA pathogenesis by secreting pro-inflammatory cytokines. The "alternatively activated macrophage phenotype" is considered to be regulatory and anti-inflammatory in tissues. Actually, there is a continuum from pro-inflammatory to anti-inflammatory macrophages, with high plasticity between the different states. We have previously shown that RA patients, and not patients with other inflammatory rheumatic diseases, have an impaired maturation of monocytes in anti-inflammatory-macrophages with increased differentiation in a pro-inflammatory-phenotype. We have found that an increased expression of miR-155 in monocytes/macrophages could be responsible for this defect and thus, could represent a new therapeutic target in RA [2].

**Objectives:** Our aim is to assess if the defect of monocytes polarization in anti-inflammatory-macrophages and the impact of miR-155 in this defect are present in 2 pre-clinical models of RA: the CIA (collagen-induce-arthritis) and STA mice (Serum transfert arthritis), both in which macrophages infiltration of synovium play a key role in pathophysiology. Then, we have tested a new therapeutic strategies to correct this defect using PEG-liposomes containing antagonomiR-155-5p.

**Methods:** AntagomiR-155-5p or antagonomiR-control were encapsulated in PEG-liposomes of 100nm in size and -10mV in zeta potential with high antagomiR loading efficiency (above 80%). Mice were injected intravenously with 1,5ml/mL PEG-liposomes containing antagonomiR-155-5p or control after induction of arthritis.

**Results:** As in humans, we found that monocytes defect in anti-inflammatory-macrophages was associated with an increase of miR-155-5p in both mouse models. Moreover, we demonstrated the biodistribution of tagged-PEG-liposomes to inflamed joints 1 hour after injection and as well as their subsequent liver's accumulation after 48 hours, indicative of hepatic clearance, in arthritic mice. Subsequently, we demonstrated that treatment with an antagomiR-155-5p encapsulated in PEG-liposomes was able to decrease joint inflammation, to restore bone-marrow monocytes polarization in anti-inflammatory-macrophages, to reduce immune cells infiltration in synovial tissues, to increase the CD206" and CD163" tissue infiltrating macrophages and to decrease expression of mRNAs target of miR-155-5p, without any significant functional change in other immune cells including splenic B and T cells.

**Conclusion:** The injection of antagomiR-155-5p encapsulated in PEG-liposomes allows delivering small RNA to monocytes/macrophages, lead to reduce joint inflammation in murine models of RA, providing a promising strategy in human disease.

**REFERENCES:**

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