HORIZON 2020

NanoSTARS imaging for STEM cell therapy for arthritic joints

Rapports

Informations projet

STARSTEM

N° de convention de subvention: 761214

Site Web du projet

DOI
10.3030/761214

Projet clôturé

Date de signature de la CE
16 Octobre 2017

Date de début
1 Janvier 2018

Date de fin
30 Juin 2022

Financé au titre de
INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies – Nanotechnologies

Coût total
€ 5 933 952,24

Contribution de l'UE
€ 5 933 952,24

Coordonné par
UNIVERSITY OF GALWAY
Ireland

Ce projet apparaît dans...

5 Juin 2023

Periodic Reporting for period 3 - STARSTEM (NanoSTARS imaging for STEM cell therapy for arthritic joints)

Période du rapport: 2021-01-01 au 2022-06-30

Résumé du contexte et des objectifs généraux du projet

STARSTEM has developed a nanotechnology-enhanced optoacoustic imaging (OAI) approach, using a novel nanostar contrast medium, which delivers unprecedented imaging depths and levels of sensitivity in identifying and tracking Mesenchymal Stem Cells (MSCs) and Extracellular Vesicles (EVs) and their healing function in osteoarthritis (OA) after administration into an affected joint.

Regenerative medicine, particularly stem cell therapy, has shown great potential in treating a wide range of illnesses, from arthritis to diabetes, and cancer to transplant rejection. However, it is not yet clear how stem cells actually work inside the body. One of the major hurdles in stem cell mediated-therapy is the inability to sensitively monitor successful engraftment or activity of transplanted stem cells in real-time or over extended periods. There is limited knowledge about their biodistribution over time, engraftment, and mechanism of action.

Our nanotechnology-enabled imaging approach will help overcome these barriers to clinical translation, with a focus on OA. Arthritis is the most prevalent disease worldwide, with OA affecting over 527 million people globally. There is no effective cure for OA at present, and the majority of the treatments are symptomatic rather than restorative. Stem cell therapy provides a unique opportunity to help restore healthy function.

As such, STARSTEM will, for the first time, enable objective measurement of functional markers of healing, including vascularisation, oxygen saturation, and inflammation, over time and at significant depth. Understanding the hallmarks of the healing process will ultimately help patients to benefit from new cell therapies.

STARSTEM is a European project, with partners hailing from five countries; Ireland, Germany, England, Spain, and Italy. The project brought together leaders in the nanomaterials, regenerative medicine, osteoarthritis, and bio-imaging fields from across Europe.

Travail effectué depuis le début du projet jusqu'à la fin de la période considérée dans le rapport et principaux résultats atteints jusqu'à présent

STARSTEM addresses major technology gaps to enable imaging of stem cells at clinically relevant depths. Our nanostar-enhanced approach has enabled us to track stem cell engraftment over time and see how MSCs behaved after administration to a joint.

STARSTEM kicked off in January 2018 and ended in June 2022. Since project kick-off, we achieved significant project objectives, including cell production; isolation of EVs from MSCs; nanostar design and production; labelling of cell products; enhancement of imaging hardware and software development; and the imaging of nanostar labelled cells in vitro and in vivo. We also addressed necessary regulatory issues, secured ethical approvals, and held regular consortium-wide meetings. We also communicated and disseminated our project and research outputs widely. Our project website (starstem.eu) and social media accounts (STARSTEM H2020 on Twitter, LinkedIn, ResearchGate) were regularly updated and we have issued press releases, promotional materials, and presented STARSTEM at numerous conferences and events.

The STARSTEM nanostar: We optimised our synthesis protocol to produce, with high yield and reproducibility, optimal gold nanostars that are resonant at around 1064 nm. This contrast medium absorbs light at the ideal wavelengths for OAI. STARSTEM has attained images at unprecedented depths, with excellent sensitivity, and can identify and track our targets. We have also scaled-up the nanostar production process in order to deliver sufficient product for preclinical research.

Cell labelling and OA therapy: Nanostar labelled MSCs and MSC-derived EVs have been administered for in vitro and in vivo models of OA. Through the optimisation of a novel medium supplement, we improved proliferation rates when culturing human MSCs. We have labelled MSCs and EVs with nanostars and have assessed the effects of this labelling process on the functional properties of the cells. We also labelled MSCs and EVs with SPIONs (Super Paramagnetic Iron Oxide Nanoparticles) in order to track these cell products with MRI. Labelled and unlabelled cell products were used in imaging, biodistribution and therapy studies.

Imaging: MSOT, a state-of-the-art OAI system (https://www.ithera-medical.com/) and MRI were used to visualise and monitor the activity of the MSCs and EVs. Imaging protocols were defined early in the project we developed new software to analyse the image data. We imaged a human finger and a sheep knee using OAI and MRI. This helped us to understand how the different imaging modalities can work together. We developed a co-registration algorithm to compare and combine OAI and MRI images. Complimentary studies with nano-sensitive OCT (optical coherence tomography, another highly sensitive imaging modality) have shown that we can detect small structural changes within tissue and the internalisation of nanostars by MSCs.

Progrès au-delà de l’état des connaissances et impact potentiel prévu (y compris l’impact socio-économique et les conséquences sociétales plus larges du projet jusqu’à présent)

STARSTEM will help scientists and clinicians to understand how stems cells actually work. A key question for regenerative medicine is the nature of the therapeutic agent – do stem cells lead to healing directly or do they communicate with the body to trigger healing at a distance? This means looking at where they go and how long they stay there, and looking at how healing occurs over time. During STARSTEM, we studied nanostar labelled MSCs and EVs both in vitro and in vivo, from the sub-cellular to whole-animal scale. This has given us exciting insights into how cell therapies work. Once published, our results will provide evidence that can help facilitate regulatory approval of regenerative therapies. The next step for nanostars will be to pass through the Clinical Trial process. Now that the project is completed, we are in a good position to apply for such a trial to examine nanostars with labelled cells in action.

STARSTEM’s focus is on better therapy through regenerative medicine – the use of cell therapies to cure previously intractable diseases. The project results have extensive benefits for the partners involved and the broader European research community. We have developed and validated a novel and highly sensitive nanotechnology-based imaging approach that enables researchers and scientists to monitor cellular transplants. OAI is non-invasive and non-traumatic. This means that it can generate high-resolution images deep inside tissues without harming the patient or study subject in any way. It also means that the same subject can be imaged repeatedly and over time, enabling a complete picture of the healing process to emerge. STARSTEM will have a profound impact on regenerative medicine research and future clinical practice because we have enabled in vivo tracking of the MSC and EV survival, engraftment, movement, and function, over extended periods and at clinically-relevant depths.

STARSTEM

STARSTEM logo

Dernière mise à jour: 9 Juillet 2023

Permalink: https://cordis.europa.eu/project/id/761214/reporting/fr