ARTHRITIS IS THE destruction of cartilage, articular structures and subchondral bone. Behind cancer and cardiovascular diseases, rheumatoid arthritis (RA) and osteoarthritis (OA) are the most prevalent global diseases. In Europe, there are 3 million RA and 70 million OA patients. Given lifestyle changes and ageing of the population, the number of arthritic patients is expected to increase, resulting in enormous medical and socioeconomic challenges.

CLINICAL HURDLES

At present, there is no effective cure for RA, although several anti-inflammatory drugs are already on the market, such as glucocorticoids and biologics. Although efficient, in long-term administration these treatments may also open up a host of serious complications including infection, hepatitis or bone marrow suppression. Similarly, therapy of OA is mainly symptomatic, aiming at reducing pain, and it is not restorative. Society needs more efficient therapies, safer drugs, better delivery systems in the area of inflammation and the ability to detect the onset of the disease as early as possible.

INORGANIC NANOPARTICLE FOR ACCURATE IMAGING

To date, it has been difficult to monitor the disease progression and define when a treatment should be initiated, as conventional imaging techniques essentially detect the advanced manifestations of the diseases. However, there are nanoparticles that can change this. In vivo molecular imaging approaches like magnetic resonance imaging (MRI) can take images of the inside of joints, synovium or articular cartilage, and use of contrast agents allows MRI to better pick up the magnetic signals and increase the differences between normal and abnormal tissues. Originally developed as negative contrast agents for liver imaging, superparamagnetic iron oxide nanoparticles (SPION) are useful tools for imaging of inflammatory diseases.

The effectiveness of this approach has been successfully demonstrated in the EU Seventh Framework Programme (FP7) Consortium NanoDiaRa – Development of Novel Nanotechnology Based Diagnostic Systems for Rheumatoid Arthritis and Osteoarthritis. Indeed, it has been shown that after intravenous injection, SPION are taken up by key players in the immune response, including monocytes and macrophages, and are transported to the inflamed tissues. These nanoparticles allow very high resolution, an accurate detection of distinct patterns of inflamed joints and quantification of the effectiveness of a treatment with dexamethasone. By monitoring the biodistribution and toxicity over time, SPION were shown to exhibit a favourable toxicological profile. Efficacy and safety studies suggested SPION could be worthy of consideration for further clinical development.

NANOPARTICLES FOR THERAPY AND DRUG DELIVERY SYSTEMS

Innovative nanodevices might advance drug delivery and therapies in arthritis patients. Nanoparticles can, for example, be engineered on their surface to reach tissues quickly and release inflammation-reducing drugs. Targeted medication means patients can take reduced doses of drugs, limiting their side effects on healthy tissues. The EU-funded ‘Folate-based nanobio-devices for integrated diagnosis/therapy targeting inflammatory diseases’ project has addressed this with surface engineered liposomal and protein-based nanoparticles of 100-400 nm. These particles were decorated with antibodies to selectively target macrophages, certifying high specificity. Simultaneously, particles filled with inflammation-reducing compounds (drug or small interfering RNA) were synthesised and shown to inhibit the signalling pathways occurring during the inflammatory processes.

ON THE HORIZON

Nanoparticles’ unique properties make them highly attractive for the design of novel therapeutic or diagnostic agents of disorders like arthritis. Lack of access to suitable capital during key development phases, the need of extensive safety data to anticipate the regulatory hurdles and the scale-up ability of the production processes are, however, important challenges to unlock the future potential of nanomedicines. Addressing these issues will be as important as the development of the nanotechnologies in forthcoming Horizon 2020 projects.

the last word: Nanoparticles for diagnosis and therapy of arthritis

Continuing our nanomedicine series, two former members of the European cluster for Targeted Nano-Pharmaceuticals and Early Diagnostics – nanotechnologist Geraldine Coullerez and Managing Partner of M3DC Sàrl, Michel Dreano – give an overview of nanomedicine-based solutions to treat arthritis.