Injuries to the tendons and ligaments are sports injuries that are difficult to treat. Hence local researchers from NUS are making use of nanotechnology to develop synthetic ligaments and tendons in the hope of ultimately coming up with fail proof synthetic ligaments and tendons to help patients.

Just like buildings made from steel and concrete using civil engineering approaches, synthetic ligaments are generated using tissue engineering approaches. If steel bars are the skeleton of the building and concrete is poured in to complete the body, then biopolymer scaffolds are the skeleton of the synthetic ligament and stem cells complete the job.

Leading the investigations are Associate Professor Toh Siew Lok from the Department of Bioengineering and Associate Professor James Goh from Department of Orthopaedic Surgery, Yong Loo Lin School of Medicine.

The scaffolds are made from a material called polylactic-co-glycolic acid (PLGA). PLGA is biodegradable and will not have any negative effects on the body when it disintegrates inside the body.

PLGA compounds into micro fibres with thickness of about 0.7mm which is then knitted into a scaffold resembling a fishing net. However, the spaces in this structure are still too large to keep the stem cells within. Hence A/P Toh made use of nanotechnology to fill up these spaces with net-like structures using nanofibres with a thickness of only 400 nm (100 nm is equivalent to a thousandth of the diameter of hair) so that the precursor cells can be trapped by "the nets within nets".

A/P Toh said that when the scaffold is ready, a layer of stem cells can be spread over it. Stem cells are obtained from the bone marrow of the human body and it can grow to form any tissue organs. It takes about 4 weeks for the scaffold to dissolve and leave tissue cells behind.

A/P Goh said that in order to induce in vitro differentiation of stem cells and the scaffold into ligaments, they also made use of the bioreactor to allow the cells to contract and stretch continuously, so that the stem cells will develop into ligament tissues. He plans do conduct experiments on rabbits next January. If the experiments are successful, further investigations will be done on larger animals like pigs and goats before proceeding into the stage of clinical experiments.

A/P Goh said, "There is a big difference between the ligament of humans and animals. This is because animals have different sports posture and so their ligaments are subjected to a different level of stress."

He estimates that it will take at least another 10 years for this synthetic ligament to become the official treatment for ligament and tendon injuries. "Clinical experiments on human will need observations of at least 7 to 8 years for data collection and finally be approved by the US Food and Drug Administration."

Besides using PLGA, they are also currently using other biomaterials of better quality such as silk. Silk is actually a stronger material which can be made into better scaffolds. This means that synthetic ligaments and tendons can be stronger, thus enhancing their effectiveness in treatment.

Research in this area began as early as 2000 in the Department of Orthopaedic Surgery, Yong Loo Lin School of Medicine while Department of Bioengineering began to look into this area two or three years ago.

A/P Goh said that the current treatment method for ligament injuries often end up in failure. This method is largely based on autograft, allotransplantation or artificial ligaments. Autografting is the removal of the ligament from other parts of one's body and transplanting it to the injured area while allotransporation uses the ligament donated by others. Artificial ligaments that available now are not made from tissue engineering.

He also pointed out that there are currently 170,000 Americans waiting to fix their damaged ligament. This is not a small number.

Besides manufacturing ligaments and tendons, bioscaffolds and stem cells can also be used to treat damaged skin and organs and they can potentially be made into blood vessels.