3Qs: New ways to treat injuries like Gronk's

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New England Patriots tight end Rob Gronkowski tore both his articular cartilage and medial cartilage ligaments in a game two weeks ago after a defender's jarring hit to his leg. The current recovery period for ligament tears is often more than a year, so the injury has ended his 2013 season and could possibly affect his availability next season. But new research from Northeastern professor Thomas Webster, chair of the Department of Chemical Engineering and an expert in nanomedicine, could change that for future athletes.

What are the challenges of treating and recovering from ACL and MCL tears like Gronkowski recently suffered?

Ligament tissue repair is extremely difficult. Only about half of those receiving treatment return to a normal active lifestyle, and most of them are not football players. The additional physical forces placed on ligaments during the sport mean an even lower chance of returning to a very active lifestyle.

Healing ligament tissue damage is difficult since the cells of the ligaments do not regenerate that quickly and the mechanical environment is very difficult to stabilize to allow healing to occur. Most treatments involve taking ligaments from another part of the body (such as the patella) and stitching it into the remaining torn ligament to heal it. Using this approach, it is very difficult to stabilize the ligament over the course of six to nine months, which is necessary for healing to occur.

(Imagine asking Gronk, or anyone, to sit in bed for that long without moving.) An even bigger problem is when the ligament is torn right at the bone interface, as ligaments naturally come out of bone; this is also very difficult to treat because of the harsh mechanical environment.

What are the new nanomedicine methods you and your colleagues at Northeastern are developing to treat ligament injuries, and how could they be used to treat injuries like Gronkowski's in the future?

We are developing two types of approaches based on nanomedicine: an injectable nanomaterial and a ligament nano bandage. With chemical engineering professor Hicham Fenniri and graduate student Linlin Sun, we are developing an injectable nanostructured material that can self assemble in the same way that nanofibers do in natural ligaments to mechanically stabilize the injury and promote healing. It is super sticky, so immediately after injection, it sticks to the torn parts the ligament and brings them together to stabilize it so that healing can occur.

In another approach, chemical engineering graduate student Dan Hickey is developing a synthetic "nano-bandage" that contains nanomaterials that adhere to and mimic the natural structure of the ligament. The nano-bandage is stitched around the injury to stabilize it and can promote healing faster than materials can today. We discovered that magnesium nanoparticles (a natural element in our diet) significantly improve the mechanical and cellular compatibility properties of the bandage and are a key ingredient in the material's ability to regenerate ligament tissue.

With both approaches, we see indications of healing times that are about three to four times faster than current practices, which would mean Gronk could return to the football field three to four times faster. But equally as important, our results suggest that when the tissue regenerates it is stronger and may reduce the concern that another tear will happen on the football field, currently a common problem for football players and all athletes.

Could these approaches be applied to treat other kinds of injuries or medical problems? If so, how would they work?

Yes, often times ligament, cartilage, tendon, and muscle tears have the same problems: the active mechanical environment makes it difficult to regenerate tissue. We need biomaterials that can first stabilize the tear and then promote tissue repair once the injury is mechanically stable. Both of the nanomedicine approaches above can mechanically stabilize the injury better than current technologies and furthermore promote various types of tissue growth, which current technologies cannot do.

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