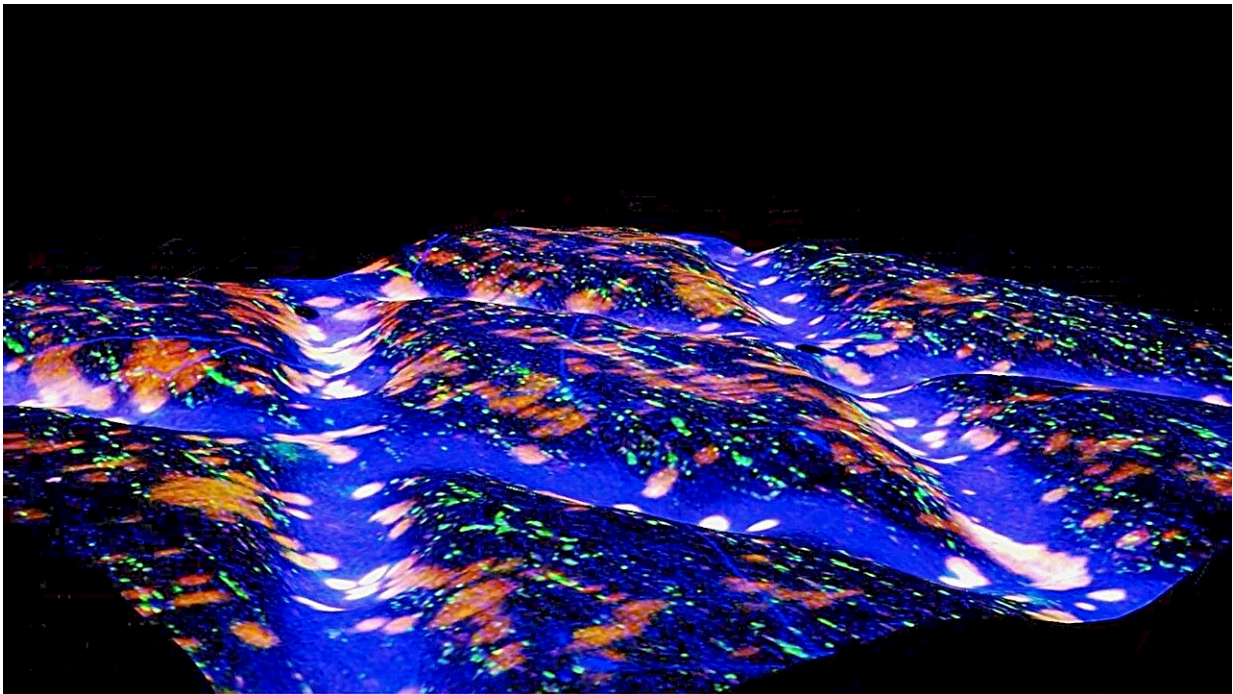


New 'patch' uses natural body motion to fix disk herniation

November 15 2023



3D reconstruction of a TARP. Credit: Penn Medicine

A new biologic "patch" that is activated by a person's natural motion could be the key to fixing herniated disks in people's backs, according to researchers at the Perelman School of Medicine at the University of Pennsylvania and the CMC VA Medical Center (CMCVAMC).

Combining years of work from many different projects, the "tension-

activated repair patches" (TARPs) provide controlled release of an anti-inflammatory molecule called anakinra from microcapsules over time, which helped disks in a large animal model regain the tension they need to reverse herniation and prevent further degeneration. This pre-clinical research is detailed in a paper [published](#) in *Science Translational Medicine*.

"Currently there is no [curative treatment](#) for disk herniation, and the best thing out there is just like sticking a plain rubber plug into a hole in a tire. It will stay for a while but it won't make a great seal," said co-senior author Robert Mauck, Ph.D., a professor in Orthopaedic Surgery and director of the McKay Laboratory for Orthopaedic Surgery Research at Penn and research career scientist and co-director of the Translational Musculoskeletal Research Center at the CMCVAMC.

"The patch we've developed is like the plug plus glue, so you're actually bonding the patch. And since biomechanical movement activates the patch and makes it seal more strongly, it's like having your tire patch get stronger the more miles you put on it."

Herniation in the spine occurs when one of the soft disks that sits between the vertebrae develops a split or a hole, and the soft interior squeezes through. This means that the disks lose their tension and are unable to cushion the spine as usual, causing pain. To continue the tire analogy, it's as if a tire has gone flat and the car is riding on its rim.

So the Penn Medicine and CMCVAMC researchers have developed TARPs to not just plug the hole, but allow tension to build back up, and re-cushion the vertebrae. That goal has been particularly tough to achieve to this point.

"The disk is a very complex tissue, which is different from muscle and skin in that it cannot heal its own structure and, in fact, continues to

degenerate over time once its structure is compromised," said Ana Peredo, Ph.D., who completed this research during her doctoral studies in Bioengineering at the School of Engineering and Applied Sciences at Penn.

"We set out to recover the disk's mechanical integrity while simultaneously attenuating inflammation in order to prevent further tissue damage and retain as much tissue function as possible." Key to the TARP is having the body's natural mechanics work to activate the release of anti-inflammatory molecules from the microcapsules within the patch. While they would theoretically still work if a person lay totally still for months, the reality of the disk tissue environment is that movement is its natural state.

And because the patch makes it as if there was never a hole to begin with, its application could have significant effects on the prevention of worsening pain related to disk degeneration.

"This is designed to be an [early intervention](#) that may change the course of disease progression," said co-senior author Harvey Smith, MD, an associate professor of Orthopaedic Surgery and attending physician at the CMCVAMC.

"Currently there's no treatment to mitigate recurring herniations that actually heal the disk. So we're looking at a disease that is very common in younger, working-age people that, downstream, leads to severe [disk](#) disease and the need for spinal fusion. The more we can prevent that, the better."

This new prospective treatment, which has human and potentially veterinary applications, builds upon many years of research in the McKay Lab and at Penn, at the Translational Musculoskeletal Research Laboratory at the CMCVAMC, and within the Institute for Medical

Translation at the New Bolton Center, and leverages foundational technologies used by many of the same researchers on this project to create bio-synthetic disks and other mechanically-activated drug delivery systems.

Some of these advances are now being commercialized by Mechano Therapeutics, LLC , which was co-founded by Mauck and other co-authors on the current paper, George Dodge, Ph.D., previously an adjunct associate professor of Orthopaedic Surgery and the current CEO of the start-up, and Daeyeon Lee, a Penn Engineering professor, and supported by the Penn Center for Innovation.

"I have been working with emerging non-fusion spine technologies for 20 years, with very few making it to [human clinical trials](#) and beyond," said Thomas Schaer, VMD, a veterinary surgeon and Director of the Institute for Medical Translation, New Bolton Center, at the Penn School of Veterinary Medicine.

"This team has been working together for 15 years, and I believe we are practicing a highly focused approach to research that has significant potential for a translational breakthrough across a broad spectrum of spine care, not just for human patients but possibly also for our furry dog friends."

While this research was primarily "proof of principle," moving this treatment closer to the clinic will require longer trials in large animal models, the team said.

"This study was incredibly promising but went for one month, so we want to test for a longer time because there are ways we can fine-tune this patch," said co-lead author Sarah Gullbrand Ph.D., a research assistant professor of Orthopaedic Surgery at Penn and research health scientist at the CMCVAMC.

"We only targeted one biologic pathway this time using something that was already approved by the FDA, but there are tons of other factors that are approved. In the future, we're interested in not only reducing inflammation, but also preventing cell death and improving overall healing."

More information: Ana Peredo et al, Tension-activated nanofiber patches delivering an anti-inflammatory drug improve repair in a goat intervertebral disc herniation model, *Science Translational Medicine* (2023). DOI: [10.1126/scitranslmed.adf1690](https://doi.org/10.1126/scitranslmed.adf1690).
www.science.org/doi/10.1126/scitranslmed.adf1690

Provided by Perelman School of Medicine at the University of Pennsylvania

Citation: New 'patch' uses natural body motion to fix disk herniation (2023, November 15) retrieved 9 May 2024 from
<https://medicalxpress.com/news/2023-11-patch-natural-body-motion-disk.html>

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