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Protein in human hair shows promise for regenerating nerves

WINSTON-SALEM, N.C. •A protein found in human hair shows promise for promoting the regeneration of nerve tissue and could lead to a new treatment option when nerves are cut or crushed from trauma.

In the current issue of Biomaterials, scientists from Wake Forest University School of Medicine reported that in animal studies the protein keratin was able to speed up nerve regeneration and improve nerve function compared to current treatment options.

We found that the nerve repair happened more quickly and consistently, and that functional recovery was higher,•said Mark Van Dyke, Ph.D., senior author and an assistant professor of regenerative medicine. The fact that we were able to accomplish this with gels made from keratin is pretty remarkable.

Current treatments for repairing damaged nerves include microsurgery to sew two ends of the nerve together, using a nerve from another part of the body to replace a damaged section, or placing an empty tube between the cut ends so that nerve fibers can grow through it and back into the muscle.

Grafting a nerve from another part of the body is usually the most effective option, but it creates another injury site and isn’t possible in all patients. The tubes, known as nerve guidance conduits, cannot be used in gaps longer than three or four centimeters. In addition, nerve regeneration with this method is not always successful. For example, after about age 17, nerves don’t regenerate as well.

Laboratory scientists have tried placing natural materials, such as collagen, into the conduits to promote nerve regeneration. Van Dyke’s team was the first to use keratin, which is believed to contain molecules that regulate cell behavior.

The scientists collected human hair from a local barber shop and chemically processed it to remove the keratin. They purified the keratin protein and used it to form gels that were then used to fill the nerve guidance conduits. They studied how keratin affects the activity of Schwann cells, which play a vital role in nerve regeneration. These cells produce signals that tell nerve cells to begin regenerating and remodel•the blood clot that has formed so that nerve cells can grow across it.

By using keratin to activate these cells, we′re trying to tap into the natural healing cascade,• said Van Dyke. We believe that keratin helps amp up Schwann cell activity and give the nerve regeneration process a head start.•/p>

The laboratory studies showed that keratin activated Schwann cells and increased their proliferation and migration. Next, the scientists used a keratin-filled tube to attempt to repair a 4 millimeter nerve gap in mice -- a fairly significant gap considering the size of the animal.

The results from these animals were compared with animals treated with an empty nerve guidance conduit and with animals treated with a nerve graft.

After six weeks, 100 percent of the animals in the keratin and nerve graft groups showed visible nerve regeneration across the gap, compared to only 50 percent who got the empty conduit. The speed of repair was best in the keratin group.

The scientists then tested the function of the regenerated nerve. The speed of nerve impulses was best in the keratin group. The amount of signal that got through the nerve was better in the keratin group than in the empty tube group. The study was recently highlighted in the journal Science.

The results suggest that a conduit filler derived from hair keratins can promote an outcome comparable to a grafted nerve,″ said Van Dyke.

In the study, the nerve function did not translate into recovery of muscle function, but the scientists suspect they may have tested too early, before the nerve had time to regenerate to the muscle. It is known that muscle function recovery lags behind nerve recovery. Future studies will focus on regeneration across larger gaps and will test whether nerve regeneration results in a return of muscle function.

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The research was conducted by the Wake Forest Institute for Regenerative Medicine (WFIRM) and the Department of Orthopaedic Surgery and was funded internally. Additional studies will be funded by the Errett Fisher Foundation.

In addition to Van Dyke, members of the research team and co-authors on the paper include graduate student Paulina Sierpinski, B.S., and orthopaedic resident Jeffrey Garrett, M.D., (co-first authors), orthopaedic resident Jianjun Ma, M.D., graduate student and orthopaedic resident Peter Apel, M.D., graduate student David Klorig, B.S., orthopaedic surgery professor Thomas Smith, Ph.D., orthopaedic surgery chair L. Andew Koman, M.D., and WFIRM director Anthony Atala, M.D.

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Wake Forest University Baptist Medical Center is an academic health system comprised of North Carolina Baptist Hospital and Wake Forest University Health Sciences, which operates the university's School of Medicine. U.S. News & World Report ranks Wake Forest University School of Medicine 18th in primary care and 44th in research among the nation's medical schools. It ranks 35th in research funding by the National Institutes of Health. Almost 150 members of the medical school faculty are listed in Best Doctors in America.