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Muscle cell infusion shown to strengthen sphincters in animals in Stanford study

BY JENNIFER WELSH

A new study shows that muscle cells grown in the lab can restore an intestine's ability to squeeze shut properly. The work, performed in dogs and rats, might ultimately help treat patients with conditions such as gastric reflux and fecal incontinence.

This technique may be used to strengthen sphincters, which are the bands of muscle that separate the major sections of your intestinal tract. Weakness in these areas can cause gastrointestinal esophageal reflux disease, or GERD, which affects 25 million adults in the United States. It is also a cause of fecal incontinence, or loss of control of the bowels, which afflicts more than 5 percent of adults under 40, especially women after childbirth; its prevalence increases with age.

"This represents a very logical and new direction for treatment of such conditions," said Stanford professor of medicine Pankaj Pasricha, MD, lead author of the study in the December 2009 issue of *Gastrointestinal Endoscopy*. "After injecting muscle cells in that area of weakness, those muscle cells thrive and get integrated into the existing tissues, and then add to the strength of the sphincter," added Pasricha, chief of gastroenterology and hepatology at Stanford.

Funding for this project came from Cook MyoSite Inc., developer of the technique used to grow muscle cells.

GERD is usually caused by a weakened sphincter at the bottom of the esophagus, the tube leading from the mouth to the stomach. If this sphincter's muscles fail to contract properly, food and stomach acids can move into the esophagus and cause symptoms including heartburn two to three times a week.

Not only do reflux sufferers experience frequent heartburn but the constant presence of stomach acid changes the cells of the esophagus in up to 10 percent of patients, a condition called Barrett's esophagus, which may become cancerous.

Patients suffering from the socially ostracizing disorder of fecal incontinence have difficulty controlling bowel movements, caused by a weakened anal sphincter or by injury to the nerves and muscles associated with controlled bowel movements.

Most reflux and some fecal incontinence patients benefit from diet and lifestyle changes and daily medications. "This is one potential advantage of this approach; it could theoretically fix the underlying problem and eliminate the need for medications," said Pasricha.

Surgery may be the only option for patients who have persistent symptoms even after medical treatments. Surgery includes altering sphincter structure or injecting bulking agents to make the opening of the sphincter smaller.

These invasive surgeries involve heavy sedation and days of recovery. The new procedure "theoretically would take about 10 minutes to do; it would be an outpatient procedure, minimal sedation and the patient could go home in about an hour," said Pasricha. A similar procedure to enhance bladder sphincter function is being tested in human trials of patients with urinary incontinence.

The new study tested whether skeletal muscle, the kind that moves your bones and is

easily accessible by biopsy, could grow and function within the smooth, not consciously controlled, muscles of the gastrointestinal sphincters. “It wasn’t clear whether in fact these two muscle types could actually integrate — both structurally as well as functionally,” said Pasricha.

To determine if this was possible, the researchers performed two experiments. Both experiments involved isolation and growth of skeletal muscle cells from the hind legs of animals in the lab and implantation of these cells into the sphincter of another animal. After four weeks, the researchers examined the sphincters to determine if the cultured cells, which were marked with a dye, had survived, integrated and become functional.

To test the cells' ability to integrate and change the sphincter’s ability to contract, 200,000 cells were injected into the sphincter separating the stomach and small intestine of six adult rats. Seven rats were injected with buffer alone, as controls. After a four-week growth period the researchers measured sphincter muscle contraction in response to the neurotransmitter acetylcholine. The sphincters injected with muscle cells had significantly higher contraction pressures. For example, at the lowest concentrations of acetylcholine, the amount of contraction more than doubled in the treatment group.

After determining that functional integration of the skeletal and smooth muscle was feasible, dogs were used to study this technique in the lower esophageal sphincter. Before injection, the dog’s baseline sphincter pressure and esophageal acidity were monitored. Four billion muscle cells were injected into the lower esophageal sphincter of each of the three dogs. When assayed again after three weeks, the sphincter pressure had doubled. They also noticed no abnormal features about the esophagus, confirming that the cells had successfully integrated into the sphincter.

Of the three dogs tested, one displayed signs of reflux disease; before the procedure, its esophagus was excessively acidic 26.5 percent of the time. After the injection, this dropped to 1.5 percent of the time, which could mean that the procedure strengthened the sphincter enough to reduce the animal’s reflux.

“The concept of culturing your own tissue and then re-implanting it to patch up some weak spots really represents thinking outside the box,” said Peter Kahrilas, MD, professor of gastroenterology at Northwestern University, who was not involved in the study. Still, he added, “Many hurdles remain to be traversed before that demonstration of feasibility translates into a viable durable therapy.”

Pasricha said he hopes to soon begin trials of the therapy in humans suffering from fecal incontinence. Pasricha’s co-authors are Ron Jankowski, PhD, director of research and product development at Cook MyoSite; Marie-Adelaide Micci, PhD, assistant professor of gastroenterology at the University of Texas Medical Branch; and Ijaz Ahmed, MD, assistant professor of respiratory care, also at UTMB.

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