

Contraction of abdominal wall muscles influences size and occurrence of incisional hernia

Samuel C. Lien, MD,^a Yaxi Hu, BS,^b Adi Wollstein, BA,^b Michael G. Franz, MD,^c Shaun P. Patel, BS,^b William M. Kuzon, Jr, MD, PhD,^{b,d} and Melanie G. Urbanchek, PhD,^b Seattle, WA, and Ann Arbor, MI

Background. Incisional hernias are a complication in 10% of all open abdominal operations and can result in substantial morbidity. The purpose of this study was to determine whether inhibiting abdominal muscle contraction influences incisional hernia formation during the fascial healing after laparotomy. We hypothesized that decreasing the deformation of the abdominal musculature would decrease the size or occurrence of an incisional hernia.

Methods. Using an established rat model for incisional hernia, a laparotomy through the linea alba was closed with 1 mid-incision, fast-absorbing suture. Three groups were compared: a sham group (sham; n = 6) received no laparotomy, and the saline hernia (SH; n = 6) and Botox hernia (BH; n = 6) groups were treated once with equal volumes of saline or botulinum toxin (Botox, Allergan) before the incomplete laparotomy closure. On postoperative day 14, the abdominal wall was examined for herniation and adhesions, and contractile forces were measured for abdominal wall muscles.

Results. No hernias developed in the sham rats. Rostral hernias developed in all SH and BH rats. Caudal hernias developed in all SH rats, but in only 50% of the BH rats. Rostral hernias in the BH group were 35% shorter and 43% narrower compared with those in the SH group (P < .05). The BH group had weaker abdominal muscles compared with the sham and SH groups (P < .05).

Conclusion. In our rat model, partial paralysis of abdominal muscles decreases the number and size of incisional hernias. These results suggest that contractions of the abdominal wall muscle play a role in the pathophysiology of the formation of incisional hernias. (Surgery 2015;158:278-88.)

From the Section of Plastic Surgery,^a University of Washington Medical Center, Seattle, Washington; the Sections of Plastic Surgery^b and General Surgery,^c Department of Surgery, University of Michigan, and the Ann Arbor Veterans Administration Medical Center,^d Ann Arbor, Michigan

AN INCISIONAL HERNIA OCCURS when the myofascial tissue surrounding a laparotomy abdominal incision fails to heal and support adequately the load-bearing muscle and tendon layers of the abdominal

This work was supported by the University of Michigan, Department of Surgery Research Advisory Committee and the NIH Short Term Training Health Professional Schools Grant T35 HL07690-23. A research stipend from the NIH Short Term Training Grant for Medical Students (T-35) was granted through the Student Biomedical Research Program at the University of Michigan Medical School.

Accepted for publication January 30, 2015.

Reprint requests: Melanie G. Urbanchek, PhD, University of Michigan, Section of Plastic Surgery, MSRB II A560, Ann Arbor, MI 48109-5456. E-mail: melurban@umich.edu.

0039-6060/\$ - see front matter

Published by Elsevier Inc.

<http://dx.doi.org/10.1016/j.surg.2015.01.023>

wall. Although operative intervention may be carried out in a technically correct manner, clinical studies have shown that incisional hernias are a complication in $\geq 10\%$ of all open abdominal cases.¹⁻³ In the United States, this incidence translates to approximately 200,000 incisional hernia repairs performed annually.⁴ Prosthetic-based repair of these defects results in recurrence rates of 2–36%.⁵⁻¹⁴ Recurrence rates after a suture repair are between 12 and 54%.^{5-7,15-18} Because most studies provide only short-term follow-up, these recurrence rates may be underestimated. Serious complications, such as enterocutaneous fistulas, bowel obstructions, and infection, can also result from incisional hernia repairs and can lead to further deterioration of a patient's condition.¹⁹ The basic biologic mechanism(s) that results in the formation of an incisional hernia remains unknown. As such, incisional hernias present an unresolved challenge to the surgery.

Surgeons consider a midline laparotomy as a tenorrhaphy of the linea alba central tendon, which traverses the abdominal wall. The oblique, transversus abdominis, and rectus abdominis (RA) muscles are continuous with the linea alba and aid with posture and respiration, flex and twist the trunk, maintain compression on abdominal organs, and act as antagonists to trunk extensors. Normal force movements of the RA muscle are directed laterally through the tendinous interstices as well as longitudinally through the serial muscle bellies of the RA. Contractions of these muscles normally stabilize the external obliques (EOs) at the midline while simultaneously shortening and stabilizing the soft tissue area between the caudad end of the sternum and the pubis. When the linea alba is cut and repaired, force moments through the central tendon are focused at the sites of sutures, which can lead to early wound failure.^{20,21} Incisional hernias are attributed in part to increasing loads on the abdominal wall that cannot be supported owing to the debilitation of the linea alba after operative intervention.^{21,22} Previous studies have shown that formation of incisional hernias is related to the distance between the muscles lying on both sides of the suture site.^{23,24} During the early stages of recovery, wounds depend exclusively on suture integrity to maintain abdominal wall closure until there is adequate healing and strength of supporting tissues to offset loads placed on the wound.²² As recovering patients increase activity and intensify loads across the wound, contractions of the abdominal wall may lead to shearing or distractive forces at the wound edge during this critical, vulnerable phase of healing.^{25,26}

Most studies aimed at preventing hernia formation focused on operative technique or the properties and utility of tools such as suture material and mesh. Nevertheless, purely surgical methods have proven unreliable.²²

In an alternative approach, we suggest that manipulation of local muscle contraction could affect the formation of incisional hernias. Partial, temporary paralysis of select abdominal musculature after laparotomy may alleviate stress and strain from the linea alba, providing a mechanism to determine whether force moments along the tendon influence the development and size of an incisional hernia. We hypothesized that incomplete, bilateral paralysis of the abdominal musculature in a rat model of incisional hernia would decrease the formation and size of incisional hernias by alleviating the local muscle deformation that leads to stress and strain along the linea alba.

Botulinum neurotoxin serotype A (BoNT-A) is used medically for partial, reversible chemical

denervation of muscle. BoNT-A works by preventing the release of neurotransmitters from excitatory axon terminals, thus inhibiting muscular contraction. The US Food and Drug Administration first approved a preparation of BoNT-A called Botox (Allergan, Inc., Irvine, CA) in 1989 for the treatment of blepharospasm and strabismus. Owing to its paralytic effects, Botox has since been applied to numerous muscle-related pathologies,²⁷ such as cervical dystonia,²⁸ head tremors,²⁹ ear clicking owing to palatal tremors,³⁰ palmar and axillary hyperhidrosis,³¹ detrusor hyperreflexia,³² gastrointestinal smooth muscle and sphincter spasms,³³ and esophageal achalasia.³⁴ Whether the paralytic effects of Botox on the abdominal wall after laparotomy can affect prophylactically incisional hernia formation is a novel approach to studying wound healing and hernia formation.

METHODS

All procedures involving rats were approved by the Institutional Animal Care and Use Committee of the University of Michigan. Rats were handled in accordance with the National Research Council's Guide for the Care and Use of Laboratory Animals, 1996.³⁵ Rats were obtained from Charles River Breeding Laboratories (Wilmington, MA) and were all of the F344 strain, male, retired as breeders, and between 8 and 10 months old.

Rat model. An established incisional hernia model in the rat (explained below) uses 2 fast-dissolving sutures to close partially the midline musculofascial incision after laparotomy. Using this model, Dubay et al¹ cite an incidence of incisional hernia of 40% at postoperative day 28. We modified this model for our study, placing 1 suture at the midpoint of the incision through the linea alba (Fig 1).

Pilot study on injection technique and Botox dosing. A single rat was studied to determine the correct dilution of Botox and to plan the spacing of drug injection sites. The rat abdominal wall was injected with 1% Evan's blue in aqueous solution and then excised for microscopic analysis. A single bolus of 0.03 mL was found to spread the dye successfully across the muscle fibers while avoiding leakage through the epimysium (Fig 2). The study also found that 14 injection sites into the abdominal wall (7 per side) provided optimal infiltration.

Previous studies have shown that the potency of Botox is dose-dependent.³⁶ By consulting dose-response curves from studies involving Botox injections into the rat gastrocnemius³⁷⁻³⁹ and the average masses of the gastrocnemius, RA, and EO muscles, we determined that a total dose of 10

Download English Version:

<https://daneshyari.com/en/article/6255350>

Download Persian Version:

<https://daneshyari.com/article/6255350>

[Daneshyari.com](https://daneshyari.com)