MAYO CLINIC

PM&R Update

Physical Medicine and Rehabilitation News Vol. 6, No. 2, 2016

INSIDE THIS ISSUE

Analyzing the Role of Diet and Exercise in Myelin Production

Myelin is essential to the conduction of nerve impulses in the brain and spinal cord, and myelin loss is a key pathophysiological component of neurological injury and disease, including multiple sclerosis, traumatic brain and spinal cord injury, stroke, and some neuropsychiatric disorders.

Identifying factors that encourage production of and protect the function of myelin-producing cells — oligodendrocytes and their progenitors (OPCs) — is an important avenue of research aimed at promoting central nervous system (CNS) health.

In a recently published article in *Biochimica et Biophysica Acta (BBA) — Molecular Basis of Disease*, Isobel A. Scarisbrick, Ph.D., director of the Central Nervous System and Neurorehabilitation Laboratory at Mayo Clinic's campus in Rochester, Minnesota, and co-authors — including Fernando Gomez-Pinilla, Ph.D., from the University of California, Los Angeles — investigate the relationship between fat intake, exercise and myelin production in mice.

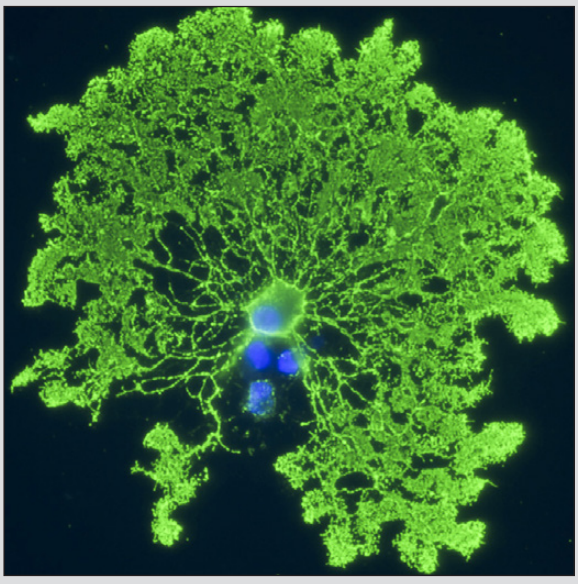

Figure 1. Myelin-producing oligodendrocyte stained immunochemically for sulfatide (green). Blue area is DAPI-stained nuclei.

The role that dietary fat intake and other external factors play in the production of oligodendrocytes and OPCs is not well-understood. Although brain lipids have high fat content, consumption of a diet containing excess fats and sugars has been shown to be detrimental to CNS function. However, myelin assembly requires a significant amount of lipids, and lipids play an important role in glial cell myelination.

Exercise has been shown to have positive effects on CNS function. Recent research has yielded evidence that exercise can modulate the action of diet on the CNS. Additional animal and human studies have shown that new myelin formation in the brain is required to learn new skills, whether it's running on an exercise wheel or learning to play the piano or juggle.

"Our study was designed to provide a clearer picture of the interaction between high fat consumption and exercise training and their effect on myelin and myelin-forming cells in the adult spinal cord," explains Dr. Scarisbrick.

Study methods

Mayo researchers studied adult mice, randomized into four experimental groups: Two groups had a sedentary lifestyle and free access to a regular diet (SRD) or a high-fat diet (SHF). Another two groups were assigned to either the regular diet (ERD) or the high-fat diet (EHF) and had free access to an exercise running wheel.

Study findings

After seven weeks, researchers analyzed the lumbosacral spinal cord tissue to measure the effects of diet and exercise on several building blocks required for myelin assembly in the four study groups, including proteolipid protein (PLP) and myelin basic protein (MBP).

Isobel A. Scarisbrick, Ph.D.

Study findings, continued

- **High-fat diet in combination with exercise training increases myelin protein expression.** PLP and MBP levels were highest in the EHF group that exercised and consumed a high-fat diet. Exercise training or high fat consumption alone also increased PLP. MBP levels in the ERD and the SHF groups were not significantly different.
- **High-fat diet alone or in combination with exercise has the greatest effect on myelin-related protein expression.** The SHF and EHF groups had the highest levels of PLP RNA. Elevations in PLP RNA induced by a high-fat diet alone (SHF) were significantly greater than those achieved by exercise training alone (ERD).
- **Exercise training protects against loss of OPCs or mature oligodendrocytes induced by a high-fat diet.** The SHF group had 30 to 50 percent fewer OPCs. While exercise alone didn't affect the OPC or oligodendrocyte numbers, mice in the EHF group did not experience OPC loss (Figure 1).
- **Exercise training in combination with a high-fat diet positively modulates expression of IGF-1 levels.** This growth factor is known to play important roles in OPC proliferation, survival and differentiation. IGF-1 RNA levels were highest in the ERD and EHF groups, suggesting that exercise exerts the greatest influence here.
- **High-fat diet in combination with exercise converges on energy bio-sensing systems to restore mitochondrial function and free radical homeostasis.** While SHF mice experienced excessive mitochondrial activity and free radical production, EHF mice up-regulated silent mating type information training (SIRT1) and the production of free radical scavengers that may protect myelin and myelinating cells from damage in the central nervous system (Figure 2).

These findings suggest that the central nervous system is capable of adapting to the demands of a high-energy Western diet when afforded ample exercise.

"Our results suggest that consuming high levels of saturated fat in conjunction with a sedentary lifestyle can lead to a reduction in myelin-forming cells. But exercise training can help reverse this process and promote the myelinogenesis necessary to meet increased energy demands," explains Dr. Scarisbrick.

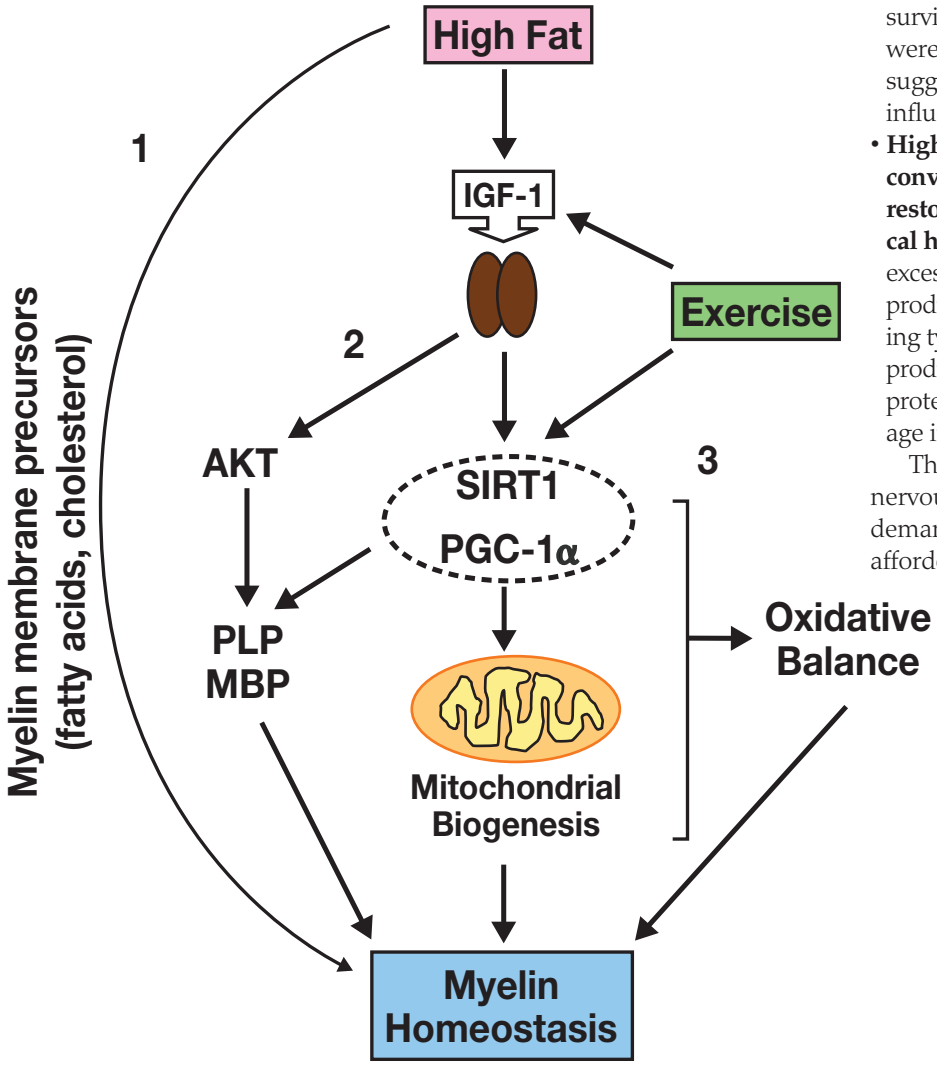

Figure 2. Hypothetical model by which dietary fat and exercise influence myelin dynamics in the adult spinal cord. 1. Dietary fat may serve as a source of myelin membrane precursors, including fatty acids and cholesterol. 2. Data presented suggest that high fat consumption on its own, or in combination with exercise, can increase IGF-1 and pro-myelinogenic signaling pathways such as AKT. 3. The interactive actions of exercise and high fat may also serve to regulate pathways associated with energy homeostasis involving mitochondrial function. Image reprinted with permission from *Biochimica et Biophysica Acta (BBA) — Molecular Basis of Disease*.

For more information

Yoon H, et al. Interplay between exercise and dietary fat modulates myelinogenesis in the central nervous system. *Biochimica et Biophysica Acta (BBA) — Molecular Basis of Disease*. 2016;1862:545.

In the News

CARF Accreditation Renewal Recognizes Innovative Programs

The Commission on Accreditation of Rehabilitation Facilities (CARF) recently renewed accreditation for seven physical medicine and rehabilitation programs at Mayo Clinic's campus in Rochester, Minnesota. The 2016 CARF survey accreditation process involved two days of interviews, presentations, shadowing sessions and more. During the exit conference, CARF surveyors noted many strengths and practices that are integral to the high-quality care provided at Mayo Clinic.

Mayo Clinic rehabilitation programs receiving CARF accreditation included the stroke, brain injury, spinal cord injury and pediatrics programs. Surveyors noted many organizational strengths at Mayo, including the extensive interdisciplinary collaboration and the strong patient focus.

Mayo staff members received praise for their dedicated leadership team, their impressive level of training, specialty certification and engagement, and their commitment to evidence-based decision-making. Mayo's depth and breadth of continuing education and competency programs, and the spacious and state-of-the-art physical facilities and equipment were also recognized.

Surveyors identified two innovative programs within Mayo's PM&R practice as exemplary:

- **The Brain Injury Coping Skills (BICS) Program, which focuses on patient and caregiver support following brain injury.** Caregivers and patients who participated in this program noted the following outcomes: a significant improvement in caregivers' ratings of patient behavioral control when evaluated using the Frontal Systems Behavior Scale; a significant improvement (from 11 to 33 percent) in patient Satisfaction With Life Scale ratings, and a significant increase (from 8 to 42 percent) in patient use of common coping strategies; and a significant decrease (from 60 to 33 percent) following treatment in the number of caregivers who rated their perceived burden of care as "high."
- **Collaboration between Mayo Clinic's Spinal Cord Injury Team and Plastic Surgery staff to reduce pressure ulcers.** Patients who were seen preoperatively for all recommended consults, including rehabilitation assessments, and optimized for surgery had improved outcomes compared to patients who did not receive preoperative intervention. Hospital length of stays decreased from 33.05 to 10.72 average days, and hospital readmission rates decreased from 12.70 to 4.5 percent.

"Our entire collaborative team is thrilled to receive these accreditations and the positive feedback that accompanied them. We are particularly pleased about CARF's recognition of Mayo's exemplary strengths and the high-quality care we provide," says Carmen M. Terzic, M.D., Ph.D., chair of Physical Medicine and Rehabilitation at Mayo Clinic's campus in Rochester, Minnesota.

Rehabilitation nurse Leah M. Karsten, R.N., educates a patient about his specific spinal cord injury and surgery, using a model and patient education materials that clearly explain the anatomy of the injury and necessary precautions.

Occupational therapist Moriah E. Kane, O.T., uses a modified notebook to assist a patient with a brain injury. The notebook exercises are designed to help the patient develop and refine writing skills and to encourage interaction with her environment. Patients admitted to Mayo Clinic's inpatient rehabilitation unit have access to a wide variety of advanced assistive technology options.

Mayo Clinic
PM&R Update

Medical Editors:
Carmen M. Terzic, M.D., Ph.D.
Mary L. Jurisson, M.D.

Follow us on Twitter: @MayoClinicPMR

Read more about Mayo Clinic PM&R at: PMRblog.MayoClinic.org

Contact Us

Mayo Clinic welcomes inquiries and referrals, and a request to a specific physician is not required to refer a patient.

Phoenix/Scottsdale, Arizona
866-629-6362

Jacksonville, Florida
800-634-1417

Rochester, Minnesota
800-533-1564

Resources

MayoClinic.org/medicalprofs

Clinical trials, CME, Grand Rounds, scientific videos and online referrals

Education Opportunities

26th Annual Mayo Clinic Symposium on Sports Medicine 2016
Nov. 11-12, 2016, in Rochester, Minn.

This course features evidence-based and cutting-edge diagnostic and treatment strategies for sports-related and musculoskeletal conditions. The multidisciplinary program includes case presentations and interactive Q&A sessions, as well as live demonstrations of physical examination, anatomy, ultrasound and arthroscopy.

11th Mayo Clinic Medical and Surgical Spine Course: Comprehensive Cervical Spine Update 2017
Jan. 13-14, 2017, in Phoenix

This course covers current and emerging spine topics driving national change in the quality and delivery of care. Participants learn new skills via didactics, case presentations and multiple skills labs.

Electromyography (EMG), Electroencephalography (EEG) and Neurophysiology in Clinical Practice 2017
Jan. 29-Feb. 4, 2017, in Amelia Island, Fla.

This course reviews techniques and topics pertaining to clinical neurophysiology and includes basic physiology, pathophysiology, EEG, evoked potentials, EMG, movement disorders and intraoperative monitoring. There is a focus on clinical correlation of various neurophysiological tests used for the evaluation of patients with epilepsy, sleep disorders, movement disorders, and peripheral nerve and neuromuscular disorders.

Sports Medicine for the Primary Care Clinician 2017
March 24-26, 2017, in Orlando, Fla.

This conference allows participants to reinforce their existing knowledge of diagnosis and treatment for musculoskeletal conditions. Topics discussed include musculoskeletal conditions and manipulation techniques that primary care clinicians can use for athletes and active individuals.

Healing & Re-engineering Minds & Bodies: Ethical Challenges in Neurology, Disabilities and Technology Assessment 2017
March 29-31, 2017, in Rochester, Minn.

This course explores the many challenging questions about what it means to be human and whether some technologies may modify normal human function or threaten individual privacy.

For more information: Visit *https://ce.Mayo.edu/physical-medicine-and-rehabilitation/pmr*, call 800-323-2688 (toll-free) or email *cme@mayo.edu*.

MAYO CLINIC | mayoclinic.org

4500 San Pablo Road
Jacksonville, FL 32224

200 First Street SW
Rochester, MN 55905

13400 East Shea Boulevard
Scottsdale, AZ 85259

MC1938-0916