Deactivating Peripheral Nerve Triggers: A Surgical Solution to Refractory Headaches

WILLIAM G. AUSTEN JR., MD
CHIEF, DIVISION OF PLASTIC & RECONSTRUCTIVE SURGERY
CHIEF, DIVISION OF BURN SURGERY
MGH TRUSTEES CHAIR

Massachusetts General Hospital, Harvard Medical School
DISCLOSURES

Founder of Cytrellis Biosystems
SOCRATIC PARADOX

WE CAN ONLY KNOW THAT WE KNOW NOTHING

-TOLSTOY
The Evolution of Ideas in Plastic Surgery

Breast reconstruction 1972-2002

Fat grafting 1982-2012

Interest over time
very early
> 1000 publications on migraine therapies/ year

\[
\frac{1}{3} \text{ of patients refractory}
\]
Migraine publications

SHOULD WE THINK ABOUT ALTERNATIVES?
Migraine Facts

324.1 million

1 in 4

Significance

35 MILLION Americans

2. Stewart et al. Cephalalgia 2008
Pathophysiology-Theory
Migraine = Brain

1. Leaõ et al. J Neurophysiol. 1944

Olesen et al. Ann Neurol 1990
Why Surgery?

Observation
Migraine Therapies

Side Effects

Contraindications

NON-Responders

1. Dodick et al. Headache 2005
New Developments- Late 1990s

Botulinum Toxin for the Treatment of Migraine

2010

FDA approved
Observation- 2000

Dr. Bahman Guyuron

349 brow-lift patients
- 79% migraine improved
CARPAL TUNNEL SYNDROME OF THE HEAD
Pathophysiology

Nerve Irritation
(muscle, fascia, bone, vessels)

→ Substance P/ Cytokines

→ Inflammation/Pain
Theory

1. Janis et. al, PRS 2010
2. Janis et. al, PRS 2010
Frontal  Occipital

Temporal  Nasal

1. Janis et. al, PRS 2010
2. Janis et. al, PRS 2010
Comprehensive Surgical Treatment of Migraine Headaches

Bahman Guyuron, M.D., Jennifer S. Kriegler, M.D., Janine Davis, R.N., and Saeid B. Amini, Ph.D., M.B.A., J.D.

Cleveland, Ohio

2005

92%

>50% reduction of migraine
2009

PLACEBO CONTROLLED TRIAL WITH SHAM SURGERY

A Placebo-Controlled Surgical Trial of the Treatment of Migraine Headaches

83.7% real surgery

57.7% sham surgery

>50% reduction of migraine

Bahman Guyuron, M.D.
Deborah Reed, M.D.
Jennifer S. Kriegler, M.D.
Janine Davis, R.N.
Nazly Pashmini, M.D.
Saeid Amini, M.B.A., J.D., Ph.D.

Cleveland, Ohio
2009
PLACEBO CONTROLLED TRIAL WITH SHAM SURGERY

A Placebo-Controlled Surgical Trial of the Treatment of Migraine Headaches

57.1 % real surgery

3.8 % sham surgery

TOTAL ELIMINATION OF MIGRAINES

Bahman Guyuron, M.D.
Deborah Reed, M.D.
Jennifer S. Kriegler, M.D.
Janine Davis, R.N.
Nazly Pashmini, M.D.
Saeid Amini, M.B.A., J.D., Ph.D.

Cleveland, Ohio
2011

Five-Year Outcome of Surgical Treatment of Migraine Headaches

88%

>50% reduction of migraine
Clinical Data

Validation of the Peripheral Trigger Point Theory of Migraine Headaches: Single-Surgeon Experience Using Botulinum Toxin and Surgical Decompression

2015

Jeffrey E. Janis, M.D.
Arjun Dhanik
Jessica H. Howard, B.A., P.A.S.

Dallas, Texas; and St. Louis, Mo.

Table 2. Summary of Migraine Surgery Studies

<table>
<thead>
<tr>
<th>Reference</th>
<th>Type of Study</th>
<th>Level of Evidence</th>
<th>No. of Patients</th>
<th>Response Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guyuron et al., 2000</td>
<td>Retrospective</td>
<td>III</td>
<td>39</td>
<td>80</td>
</tr>
<tr>
<td>Guyuron et al., 2002</td>
<td>Prospective</td>
<td>II</td>
<td>22</td>
<td>95</td>
</tr>
<tr>
<td>Dirnberger and Becker, 2004</td>
<td>Prospective</td>
<td>II</td>
<td>60</td>
<td>68</td>
</tr>
<tr>
<td>Guyuron et al., 2005</td>
<td>Prospective</td>
<td>II</td>
<td>89</td>
<td>92</td>
</tr>
<tr>
<td>Poggi et al., 2008</td>
<td>Retrospective</td>
<td>III</td>
<td>18</td>
<td>67</td>
</tr>
<tr>
<td>Guyuron et al., 2009</td>
<td>RCT</td>
<td>I</td>
<td>49</td>
<td>84</td>
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RCT, randomized controlled trial.
*Submitted for review.

A Socioeconomic Analysis of Surgical Treatment of Migraine Headaches

Carey Faber, M.D.
Ryan M. Garcia, M.D.
Janine Davis, R.N.
Bahman Guyuron, M.D.

Dallas, Texas; Durham, N.C.; and Cleveland, Ohio

A Review of Current Evidence in the Surgical Treatment of Migraine Headaches

> 50% improvement between 62-95%
Looking back on my own practice…

Oct 2008
Gathering a Team

2009
The 1st Year

2009

1

5

SURGERY

NEW CONSULTS
The 2nd Year

2010

2

7

SURGERY
NEW CONSULTS
Challenges

Patient recruitment
Skepticism - Neurology
Patient selection
Insurance coverage
Importance of Media

The Boston Globe

Migraine sufferers may find relief in plastic surgery techniques
CUTTING EDGE IN MIGRAINE TREATMENT
A new procedure that uses plastic surgery techniques offers hope to people who have long suffered debilitating pain in their heads.
Since 2011 Increased Interest
Challenges

Patient recruitment

Skepticism - Neurology

Patient selection

Insurance coverage
The art of identification

Patient must **HAVE BEEN** followed by a **NEUROLOGIST**

1. Establish diagnosis in refractory patient

1. Identification of specific trigger points

1. Clinical evaluation & diagnostic testing
The art of identification

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1. Clinical evaluation & diagnostic testing
Comparison from a surgeons view

Migraine

• ‘Deep’ undefined pain
• Starting point unclear

Nerve compression headache

• Specific pain points
• Starts at specific location
Frontal trigger site - SON, STN
Frontal trigger-common history

- Pain above the eyebrows
- Tender to touch
- In the afternoon
- Deep frown lines
- Eyelid ptosis common
- Pressure/Compresses help
Frontal Trigger Site
Frontal pain diagram
Abnormal frontal pain diagram
Temporal trigger site - ZT
Temporal trigger - common history

- Pain starts at temple
- Patients wake up with pain
- Bruxism very common
- Often throbbing pain
- Pressure/ compresses help
Temporal trigger site
Temporal pain diagram

Patients will usually mark with an x or dot in this region.
Abnormal temporal pain diagram
Occipital trigger site - GON

occipital protuberance

3cm

1.5cm

3cm
Occipital trigger - common history

- Pain starts above GON
- No specific start time for pain
- History of trauma common
- Neck muscles tight
- Worse with exercise/heavy lifting
Occipital trigger site
Occipital pain diagram
Occipital pain diagram
Abnormal occipital pain diagram
Rhinogenic trigger site
Rhinogenic trigger-common history

- Pain starts behind the eye
- Patients are woken up by pain
- Menstrual cycle/weather/allergy can change pain
- Decongestants help
- Rhinorrhea common
- Septal deviation/concha bullosa/Haller’s cell common
Rhinogenic pain diagram
The art of identification

Patient must HAVE BEEN followed by a NEUROLOGIST

1. Establish diagnosis in refractory patient

1. Identification of specific trigger points

1. Clinical evaluation & diagnostic testing
Botox/ Nerve blocks?

Positive botulinum toxin type a response is a prognosticator for migraine surgery success.
Lee M, Monson MA, Liu MT, Reed D, Guyuron B.

A Comparison of Outcome of Surgical Treatment of Migraine Headaches Using a Constellation of Symptoms versus Botulinum Toxin Type A to Identify the Trigger Sites
Mengyuan T. Liu, B.S.
Bryan S. Armijo, M.D.
Bahman Guyuron, M.D.

Cleveland, Ohio
Doppler Ultrasound

Arterial versus non-arterial trigger

- Especially useful in identification of minor triggers
- Too early to understand impact
Doppler exam
CT scan

Detection of nasal pathology

Deviated Septum/Concha Bullosa

Haller Cell
Two Pathways

History/ Nerve Block and/or Botox Injection/ Doppler/ Imaging to identify trigger sites

NEUROLOGY PAIN SERVICE ENT
Posterior triggers GON/LON
GREATER OCCIPITAL NERVE

6 COMPRESSION POINTS
Injection local
Incision
Dissection
Fascia elevation
Fascia elevation
GON exposure
GON exposure
Muscle removal
Muscle removal
Post fascia and muscle removal
OCCIPITAL ARTERY

GON
Adipose fat flap
Complete release
Closure and drain
Frontal Trigger Site - Surgical Approach

Endoscopic  VS.  Open
Anatomy SON/STN
Removal Upper Eyelid Skin
Dissection to the Orbital Rim
Dissection to the orbital rim
Identification of Nerves
Frontal Trigger Site- SON/STN

Supraorbital Nerve

Supratrochlear Nerve
Fascial band versus supraorbital foramen

Foraminectomy
Supraorbital Foramen
Two nerves exiting through foramen
Very high supraorbital foramen
Nerve exiting supraorbital foramen
Frontal - Anatomy
Aberrant Nerve
Exposure of Corrugator Superctiiii
Removal of Corrugator Supercilii
Exposure/Removal Corrugator
Post-Release
Adipose Flap
Adipose Flap
Zygomaticotemporal nerve

Superficial temporal artery
Auriculotemporal nerve
Temporalis
Zygomaticotemporal branch
Posterior surface of the frontal process of the zygoma
Nasion
Lateral orbital rim

Temporal Trigger Site

Endoscopic

Blepherooplasty approach to ZT
Dissection to sentinel Vein
Identification and removal ZT

sentinel vein

zygomatico-temporal nerve
Video ZT release
Nonendoscopic Deactivation of Nerve Triggers in Migraine Headache Patients: Surgical Technique and Outcomes

Lisa Gfrerer, M.D.
Daniel Y. Maman, M.D.
Oren Tessler, M.D.
William G. Austen, Jr., M.D.
Boston, Mass.

Background: Low efficacy, significant side effects, and refractory patients often limit the medical treatment of migraine headache. However, new surgical options have emerged. Dr. Bahman Guyuron and others report response rates between 68 and 95 percent after surgical deactivation of migraine trigger sites in select patients. In an effort to replicate and expand migraine trigger-site deactivation surgery as a treatment option, the authors’ group and others have developed nonendoscopic algorithms. The exclusion of endoscopic techniques may be useful for surgeons with little experience or limited access to the endoscope and in patients with challenging anatomy.

Methods: Forty-three consecutive trigger deactivation procedures in 35 patients were performed. Preoperative and 12-month postoperative migraine questionnaires and patient charts were reviewed. Response to surgery in terms of migraine symptom relief and adverse events were evaluated.

Results: The overall positive response rate was 90.7 percent. Total elimination of migraine headaches was reported in 51.3 percent, greater than 80 percent resolution of symptoms was reported in 20.5 percent, and 28.2 percent had resolution between 50 and 80 percent. No significant effect was reported following 9.3 percent of procedures. There were no major adverse events.
## Results Migraine Headache Frequency

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before Surgery</th>
<th>After Surgery (12 mo)</th>
<th>Average Difference from Baseline</th>
<th>p†</th>
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<tr>
<td>Migraine headache frequency (days/mo)</td>
<td>18.5 ± 10.4</td>
<td>3.7 ± 6.0</td>
<td>14.7 ± 9.9</td>
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<tr>
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MH, Migraine Headache Index.
*All values are expressed as mean ± SD.
†The p values were obtained from t tests.

**Frequency (d)**

- **Preop**: 18.5
- **Postop**: 3.7

p<0.01
## Results Migraine Headache Duration

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**Duration (h)**

- Preop **16.8**
- Postop **4.8**

$p<0.01$
Results Migraine Headache Intensity

| Variable                                      | Before Surgery | After Surgery (12 mo) | Average Difference from Baseline | p†   
|-----------------------------------------------|----------------|-----------------------|----------------------------------|------
| Migraine headache frequency (days/mo)         | 18.5 ± 10.4    | 3.7 ± 6.0             | 14.7 ± 9.9                       | <0.01 |
| Migraine headache duration (days)             | 0.7 ± 0.5      | 0.2 ± 0.4             | 0.5 ± 0.3                        | <0.01 |
| Migraine headache intensity (scale of 1–10)   | 9.2 ± 1.0      | 3.3 ± 3.3             | 5.9 ± 3.3                        | <0.01 |
| MH    | 99.4 ± 95.7    | 10.1 ± 18.0          | 89.3 ± 92.3                    | <0.01 |

MH, Migraine Headache Index.
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Pain (0-10)

Preop 9.2
Postop 3.3

p<0.01
Results Migraine Headache Index

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Migraine headache index =

\[ \text{Frequency (d) \times Duration (1/24) \times Severity (0-10)} \]

Preop 99.4
postop 10.1

-90%
p<0.01
Post- Surgical Response Rates

- > 50%: 90.9%
- < 50%: 9.3%
Positive Response Distribution

- 100%: 51.3%
- > 80%: 28.2%
- 50-80%: 20.5%

Migraine Headache Index Improvement:
- 100%
- > 80%
- 50-80%
Post-Operative Management

PATIENTS DO VERY WELL POST OPERATIVELY

Happy Patients…Happy Doctors!
Low Incidence of Adverse Events

Neuropraxia

Neurontin®
(gabapentin)

Shooting nerve pain/ numbness

Acute migraine attack

Hypertrophic scar

Additional surgery
Post-Op Management

Post-Op pain medication plan

Neurologist and PCP
Pain Specialist

Encourage:
• Patient to contact Neurologist
• Patient to speak about their surgery and result
From art... To science...
What are the important questions?

Working? How well?

Evaluate/ communicate results?

Screening?
Migraine Q

Screening

Evaluation
Questions are a powerful tool
Current Migraine Questionnaires

**MIDAS Questionnaire**

**PHQ 9**

**HEADACHE IMPACT TEST™**

Migraine Specific Quality of Life Questionnaire

The migraine work and productivity loss questionnaire
Migraine Q
Screening Tool for doctors
Evaluation Tool for patients
Prospective questionnaire study

For Migraine & Chronic Pain

Migraine Headache Index

Pain Self Efficacy Questionnaire

PHQ 2
Preliminary Results Questionnaires

Migraine Headache Frequency (days per month)

mean values; unpublished data

* p<0.01
Preliminary Results Questionnaires

Migraine Headache Duration (hours)

mean values; unpublished data

* p<0.01
Preliminary Results Questionnaires

*Migraine Headache Severity (0-10)*

mean values; unpublished data

* p<0.01
Preliminary Results Questionnaires

Migraine Headache Index

Frequency (d) x Duration (1/24) x Severity (0-10)

-85.7%

-93.5%

mean values; unpublished data

* p<0.01
Comparison % improvement

prospective

- 8.4%
- 91.6%

Improvement

- >50%
- <50%

retrospective

- 9.3%
- 90.9%

Improvement

- >50%
- < 50%
Comparison positive response distribution

prospective

- 18.2%
- 39.4%
- 42.4%

Improvement

retrospective

- 51.28%
- 28.20%
- 20.51%

Improvement
Pain Self Efficacy

Confidence in performing normal activities

I can still accomplish most of my goals in life, despite the pain. I can enjoy things, despite the pain.

0 1 2 3 4 5 6
Not at all Confident Completely confident

low pain self efficacy = POOR outcomes

Vranceanu AM et al., J Hand Surg Am. 2010
Kennedy SA et al., J Hand Microsurg. (2010)
Pain Self Efficacy
Treatment Comparison

Pre- Treatment Scores

- Migraine: 19 (unpublished)
- Chronic Back Pain: 38
- Carpal Tunnel Syndrome: 48

Pain Self Efficacy Treatment Comparison

Post- Treatment Scores

- Carpal Tunnel Pre: 48
- Carpal Tunnel Post: 52 (+8%)
- Chronic Back Pain Pre: 38
- Chronic Back Pain Post: 43 (+13%)
- Migraine Pre: 19
- Migraine Post: 47 (+147%)

Age of onset matters

Mean age at onset 23.9 ± 14.4 (Range 2-61)

Age of onset >40

- 0-50% improvement: 50%
- 50-80% improvement: 0%
- > 80% improvement: 50%

p<0.05
Duration matters

Mean duration in hours

p<0.05
Predictive Variables

Patients do better... when bothered by...
Predictive Variables
Nausea

<table>
<thead>
<tr>
<th></th>
<th>Nausea</th>
<th>No Nausea</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50% improvement</td>
<td>0%</td>
<td>38%</td>
</tr>
<tr>
<td>50-80% improvement</td>
<td>6%</td>
<td>12%</td>
</tr>
<tr>
<td>&gt; 80% improvement</td>
<td>94%</td>
<td>50%</td>
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</tbody>
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\( p < 0.01 \)
Predictive Variables

Patients do better... when relieved by...
Predictive Variables
Hot and Cold Compresses

hot and cold compresses help

<table>
<thead>
<tr>
<th>Improvement Level</th>
<th>Hot and Cold Compresses Help</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50% improvement</td>
<td>0%</td>
</tr>
<tr>
<td>50-80% improvement</td>
<td>4%</td>
</tr>
<tr>
<td>&gt; 80% improvement</td>
<td>96%</td>
</tr>
</tbody>
</table>

hot and cold compresses don’t help

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p < 0.05
What are the important questions?

Pathomechanism

Imaging

...
Pathomechanism

Migraine Tissue Bank

.. First Migraine Tissue Bank to our knowledge
Imaging

Thermal Imaging

Can we predict nerve compression and surgery outcomes?
Early days-
Thermal Imaging

Pre-operative thermal image

Prediction & intraop finding

**Right**- Supraorbital foramen

**Left**- Notch
Deactivating Peripheral Nerve Triggers: A Surgical Solution to Refractory Headaches

WILLIAM G. AUSTEN JR., MD
CHIEF, DIVISION OF PLASTIC & RECONSTRUCTIVE SURGERY
CHIEF, DIVISION OF BURN SURGERY
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Massachusetts General Hospital, Harvard Medical School