

A Socioeconomic Analysis of Surgical Treatment of Migraine Headaches

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Background: This study is meant to compare the direct and indirect cost of migraine headache care before and after migraine surgery and to evaluate any postoperative changes in patient participation in daily activities.

Methods: Eighty-nine patients enrolled in a migraine surgery clinical trial completed the Migraine-Specific Quality-of-Life Questionnaire, the Migraine Disability Assessment questionnaire, and a financial cost report preoperatively and 5 years postoperatively.

Results: Mean follow-up was 63.0 months (range, 56.9 to 72.6 months). Migraine medication expenses were reduced by a median of \$1997.26 annually. Median cost reduction for alternative treatment expenses was \$450 annually. Patients had a median of three fewer annual primary care visits for the migraine headache treatment, resulting in a median cost reduction of \$320 annually. Patients missed a median of 8.5 fewer days of work or childcare annually postoperatively, with a median regained income of \$1525. The median total cost spent on migraine headache treatment was \$5820 per year preoperatively, declining to \$900 per year postoperatively. Total median cost reduction was \$3949.70 per year postoperatively. The mean surgical cost was \$8378. Significant improvements were demonstrated in all aspects of the Migraine-Specific Quality-of-Life Questionnaire and the Migraine Disability Assessment questionnaire.

Conclusions: Surgical deactivation of migraine trigger sites has proven to be effective for the treatment of severe migraine headache. This study illustrates that the surgical treatment is a cost-effective modality, reducing direct and indirect costs. Patients may also expect improvements in the performance of and increased participation in activities of daily living. (*Plast. Reconstr. Surg.* 129: 871, 2012.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Migraine headache is a common and debilitating disorder. In 1999, the American Migraine Study II estimated that 27.9 million people in the United States suffer from migraine headache, indicating a prevalence of 18 percent of women and 6 percent of men in the United States.¹ More current studies have estimated that migraine headache affects 37 million people in the United States, or 12 percent of the entire population.² The prevalence of migraine headache is highest in patients aged 25 to 55 years,

corresponding to peak years of work productivity and child rearing.²⁻⁵

The costs associated with migraine headache are immense. The estimated total annual cost (indirect and direct costs) spent toward the treatment of migraine headache in the United States is \$13 to \$17 billion.⁶ The direct cost of treating migraine headache, excluding over-the-counter medications, is approximately \$1 billion each year.⁷ Direct costs incurred for outpatient services include prescription medications; laboratory and diagnostic services; alternative treatments such as acupuncture; and office, clinic, and emergency room visits. Annual direct cost estimates of migraine treatment range from \$552 to \$7089 per patient.⁴ Despite these staggering figures, an even

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greater burden occurs indirectly to patients, families, and society. In 1999, Hu et al. reported that migraine headache resulted in 112 million bedridden days each year, costing American employers \$13 billion in missed work days and impaired productivity.⁷ Recent estimates have suggested that the annual indirect cost of migraine headache is \$4453 per patient.⁸

One alternative to the current treatment of migraine headache is the surgical deactivation of trigger sites. Recent studies have demonstrated success following this treatment modality but at a higher initial cost.⁹⁻¹⁴ Furthermore, numerous reports have demonstrated the lifestyle and cost benefit of preventative medical treatment for migraine headache,¹⁵⁻¹⁹ but less has been reported on similar cost benefits of surgical management for future migraine prevention.¹¹ The purpose of this study was to determine the specific cost reductions (direct and indirect) to patients and society following the surgical treatment of migraine headache. In addition, we aim to evaluate whether patients who underwent surgical treatment have an improvement in the performance of activities of daily living.

PATIENTS AND METHODS

Institutional review board approval was obtained before the collection of data in this study. The recruited volunteers were examined by a team of neurologists to ensure the diagnosis of migraine headache in accordance with the guidelines established by the International Headache Society. The study population consisted of 125 patients enrolled in a previous prospective clinical trial evaluating the surgical treatment for migraine headaches.¹¹ One hundred patients were assigned randomly to the treatment group and 25 served as controls. These control patients were offered surgery at 1 year into that study. As described previously,¹⁰⁻¹² patients underwent the operative procedure(s) appropriate to their symptomatology found on history and physical examination; their preoperative response to botulinum toxin (Botox Cosmetic; Allergan, Inc., Irvine, Calif.) injections to the corrugator, occipital, and temporal regions; and demonstration of intranasal abnormality on computed topographic scan.

As part of the initial clinical trial of surgical treatment of migraine headaches, volunteers were asked to complete a series of previously validated questionnaires before treatment and again at 5-year follow-up. The Migraine-Specific Quality-of-Life Questionnaire²⁰ was specifically used to analyze the impact of migraine headache on activi-

ties of daily living over a 4-week period. The Migraine Disability Assessment questionnaire²¹ was used to measure the effect of migraine headache on daily functioning in both the home and workplace, and to quantify the severity and frequency of migraine headache over a 3-month period.

To analyze the financial burden of migraine headache, patients were asked to document the frequency and associated costs attributed to any form of treatment used toward migraine headache. This included the costs of medication (both prophylactic and abortive), alternative treatment modalities (e.g., biofeedback, massage, chiropractic, acupuncture), doctors visits, emergency room visits, days of work missed, childcare, other financial costs (e.g., unused airline tickets or missed events and obligations), and income losses. Medical costs were then evaluated as a sum of the value paid by the patient and their insurer to minimize any interpatient variation in insurance plans or variation in insurance coverage over time.

Only costs directly attributable to the treatment of migraine headache were analyzed. Reported costs and medication frequency were assumed to be accurate. When only the frequency of medication use was reported (19 patients), its associated cost was extrapolated using standardized estimates. Missing cost estimates for alternative treatments (i.e., chiropractic, biofeedback, massage, and acupuncture) and for doctor visits for migraine care were obtained by averaging fees quoted by five different providers in Greater Cleveland, Ohio (Table 1). One patient's emergency room visit did not have an associated cost reported. We therefore used the average value of \$238.16 as reported previously.²²

Mean total reimbursement per patient including all payments by patients or insurance companies (e.g., consultation fee, surgical fees, anesthesia, facility costs, laboratory tests, electrocardiography, and chest radiography) was calculated for 20 self-pay and 20 third-party reimbursements for an additional 40 patients because the surgical procedures on the initial 91 patients in the main study were performed gratuitously.

Statistical Analysis

Comparisons between preoperative and postoperative patient costs and patient responses to Migraine-Specific Quality-of-Life Questionnaire and Migraine Disability Assessment questionnaires were analyzed using a paired comparison method to minimize the effect of demographic

Table 1. Estimates of Alternative Treatment Costs

Treatment	Estimated Cost
Chiropractic (per visit)	
Mean	\$60
Range	\$36–\$130
Massage (per hour)	
Mean	\$60
Range	\$45–\$120
Biofeedback (per session)	
Mean	\$60
Range	\$35–\$85
Acupuncture (per session)	
Mean	\$45
Range	\$30–\$75
Neurologist (per visit)	
Mean	\$100
Range	\$60–\$355
ER (per visit)	
Mean	\$238.16
Range	\$138.53–\$413.94*

ER, emergency room.

*As reported by Barron R, Carlsen J, Duff SB, Burk C. Estimating the cost of an emergency room visit for migraine headaches. *J Med Econ.* 2003;6:43–53.

variations. The distribution of preoperative and postoperative data was found to be nonparametric. Therefore, median values are reported and a signed-rank test was used to determine differences in these median values. A value of $p \leq 0.05$ was considered significant. Confidence intervals were not calculated for the individual Migraine-Specific Quality-of-Life Questionnaire questions because the Likert scales used (1 to 6) were considered small, and calculated changes were narrow.

RESULTS

Study Population

Of the original 100 patients randomized to the treatment group, 91 had successful detection and confirmation of the trigger sites and underwent surgery, 89 were followed for 1 year,¹¹ and 79 completed follow-up requirements for the entire 5-year period. Of the original 25 patients random-

ized to the control group, 15 later underwent surgery and 10 completed follow-up requirements for the entire 5-year period. Therefore, financial data for 89 patients were available for this study. There were 82 women and seven men. Mean follow-up was 63.03 months (range, 56.9 to 72.63 months). The mean age at the time of migraine headache surgery was 45 years (range, 21 to 63 years). The average number of trigger sites deactivated was 2.855 (range, 1 to 4). Seven patients had surgery on one site, 21 patients had surgery on two sites, 39 patients had surgery on three sites, and 22 patients had surgery on four sites. Of the 89 patients, 25 had complete elimination (28.09 percent), 55 patients had significant improvement (61.79 percent), and nine had no significant improvement (10.11 percent) of migraine headache.

Patient Financial Reports

At 5 years postoperatively, the median cost reduction for migraine medication expenses was \$1997.26 per year ($p < 0.0001$). In addition, the median cost reduction for any alternative treatment modality was \$450 per year ($p < 0.0001$), with patients reporting a median of five fewer alternative treatment sessions per year ($p < 0.0001$). The median cost reduction for doctor visits directly attributed to the treatment of migraine headache was \$320 per year ($p < 0.0001$), with patients reporting a median of three fewer doctor visits per year ($p < 0.0001$) (Table 2).

Patients missed a median of 8.5 fewer work or childcare days per year secondary to the relief of migraine symptoms ($p < 0.0001$). Patients also had a median of \$1525 annual income regained ($p < 0.0001$). The median and mean cost of childcare (reported for four patients) related to migraine symptoms was not significantly different ($p = 0.1250$) (Table 3).

Table 2. Change in Cost per Year from Baseline to 5 Years Postoperatively

Outcomes Measured	No. (%)	1st Quartile	Median	3rd Quartile	<i>p</i>	NP 95% CI
Total migraine medicine cost	89 (93.7)	-\$481	-\$1997.26	-\$3990.96	<0.0001	-\$1629 to -\$2807
Total alternative treatment cost	53 (55.8)	\$50	-\$450	-\$1490	0.0009	-\$221 to -\$935
Total doctor costs	84 (88.4)	-\$188	-\$320	-\$780	<0.0001	-\$310 to -\$700
Total ER costs	34 (35.8)	-\$285	-\$950	-\$4035	<0.0001	-\$700 to -\$3025
Total income lost	44 (46.3)	-\$476	-\$1525	\$2761.50	<0.0001	-\$1250 to \$2879
Cost for childcare	4 (4.2)	-\$79.25	-\$248.50	-\$427.50	0.1250	-\$60 to -\$450*
Other costs	14 (14.7)	\$116	-\$303	-\$3375	0.0494	-\$10 to -\$7938
Total costs	89 (93.7)	-\$1698	-\$3949.70	-\$9529	<0.0001	-\$3776 to \$6596

NP, nonparametric; CI, confidence interval; ER, emergency room.

*Relaxed 80 percent confidence interval was required for this variable because of the limited amount of data available for analysis.

Table 3. Change in Time Lost Because of Migraines from Baseline to 5 Years Postoperatively

Outcomes Measured	No. (%)	1st Quartile	Median	3rd Quartile	<i>p</i>	NP 95% CI
No. of alternative treatment sessions	53 (55.8)	3.5	-5.0	-12.5	<0.05	-0.5 to -10
No. of doctor visits	84 (88.4)	-2.00	-3.00	-8.75	<0.0001	-2.0 to -6.0
No. of days missed from work or child care	71 (74.7)	-2.0	-8.5	-26.0	<0.0001	-7 to -16.5

NP, nonparametric; CI, confidence interval.

Cost Associated with Migraine Elimination

Of the 25 patients who reported complete elimination of their migraine headaches, 12 patients had zero costs at 5 years. Five patients had costs less than \$10 at 5 years attributable to the use of over-the-counter medication such as Excedrin (Novartis Consumer Health, Inc., Parsippany, N.J.) or ibuprofen. Six patients had mean costs of \$86.88 (range, \$70 to \$120) associated with occasional use of prescription medication at 5 years. One patient had \$2 in over-the-counter medication costs and had two massages that totaled \$202 at 5 years. One patient reported complete elimination of migraine headache at 5 years but continued to use Imitrex (GlaxoSmithKline, Research Triangle Park, N.C.), totaling \$1000 at 5 years.

Other Cost Reductions

Although the sample was small, reductions were demonstrated following surgery in the category of "other financial costs." At 5 years postoperatively, 14 patients reported a median reduction of \$303 per year ($p < 0.0494$).

Cost of Surgery

Total surgical costs varied secondary to the total number of trigger sites deactivated and the associated surgical facility and anesthetic times. The mean surgeon's fee was \$5445.84, the mean facility fee was \$1287.35, the mean anesthesia fee was \$983.27, the mean consultation visit fee was \$187.77, the mean routine laboratory work fee was \$107.20, the chest radiography fee was \$177, and the electrocardiography fee was \$192. The mean reimbursement for all associated costs, including consultation, laboratory work, electrocardiography, chest radiography, surgery, anesthesia, and facility fees, was \$8378.

Total Cost Reduction

Total median cost reduction was \$3949.70 per year at 5 years postoperatively ($p < 0.0001$). Six patients reported total cost increases. The median total cost was \$5820 per year preoperatively and \$900 per year postoperatively.

Extrapolated 5-Year Direct and Indirect Cost Savings

The median total cost savings was \$3949.70 per year at 5 years postoperatively. It can be extrapolated that the median cost savings over a 5-year period is \$19,749 (Table 4). This represents an estimated 5-year savings of approximately \$11,371 after accounting for surgical cost. In addition, over 5 years, patients can expect to have 43.5 fewer doctor visits, 25 fewer alternative treatment sessions, and 40.25 fewer days missed from work.

Migraine-Specific Quality-of-Life Questionnaire

All aspects of the Migraine-Specific Quality-of-Life Questionnaire showed a statistically significant median improvement of 1 to 2 points. Greatest improvements occurred in patient-reported perceptions of how migraine headache interfered with leisure time, caused difficulty at work, minimized the extent of work completed, limited their energy, and caused frustration.

Using these individual scores, the algorithm of the questionnaire produces a Role Function-Restrictive score, a Role Function-Preventive score, and an Emotional Function score on a scale of 0 to 100 (0 = minimal functioning and 100 = maximum functioning). The median improvement at 5 years postoperatively was 31 points ($p < 0.0001$) for Role Function-Restrictive scores, 20 points ($p < 0.0001$) for Role Function-Preventive scores, and 33 points ($p < 0.0001$) for Emotional Function scores (Table 5).

Table 4. Extrapolated Cost Savings over a 5-Year Period

Outcomes Measured	Extrapolated Savings over 5 Years
Total migraine medicine cost	\$9987
Total alternative treatment cost	\$2250
Total physician cost	\$1600
Total emergency room cost	\$4750
Total income lost	\$7625
Cost for childcare	NS
Other costs	\$1515
Total cost	\$19,749

NS, not significant.

Table 5. Changes in Response to Migraine-Specific Quality-of-Life Questionnaire at 5 Years Postoperatively

	No.	1st Quartile	Median	3rd Quartile	<i>p</i>
In the past 4 weeks, how often...					
Have migraines interfered with how well you dealt with family, friends, and others who are close to you?	88	0	-1	-2.75	<0.0001
Have migraines interfered with your leisure time activities, such as reading or exercising?	88	-0.25	-2	-3	<0.0001
Have you had difficulty in performing work or daily activities because of migraine symptoms?	88	-0.25	-2	-2	<0.0001
Did migraines keep you from getting as much done at work or at home?	88	-1	-2	-3	<0.0001
Did migraines limit your ability to concentrate on work or daily activities?	88	0	-1	-2	<0.0001
Have migraines left you too tired to do work or daily activities?	88	0	-1	-3	<0.0001
Have migraines limited the number of days you have felt energetic?	88	0	-2	-2	<0.0001
Have you had to cancel work or daily activities because you had a migraine?	88	0	-1	-2	<0.0001
Did you need help handling routine tasks such as everyday household chores, doing necessary business, shopping, or caring for others, when you had a migraine?	88	0	-1	-2	<0.0001
Were you not able to go to social activities to deal with migraine symptoms?	88	0	-1	-2	<0.0001
Were you not able to go to social activities such as parties, dinner with friends, because you had a migraine?	88	0	-1	-2	<0.0001
Have you felt fed up or frustrated because of your migraines?	88	-1	-2	-3	<0.0001
Have you felt like you were a burden on others because of your migraines?	88	0	-1	-3	<0.0001
Have you been afraid of letting others down because of your migraines?	88	0	-1	-2	<0.0001

1 = none of the time, 2 = a little bit, 3 = some of the time, 4 = a good bit of the time, 5 = most of the time, and 6 = all of the time.

Migraine Disability Assessment Questionnaire

All portions of the Migraine Disability Assessment questionnaire showed statistically significant improvements. Over a 3-month period, patients reported increased productivity in the workplace and home and fewer missed days of work, missed housework, and missed family and leisure time. Patients reported fewer days with headaches and decreased headache severity. Using the algorithm of the questionnaire, these individual data points were compiled to create a Migraine Disability Assessment questionnaire score of 1 to 4 (1 = little or no disability, 2 = mild disability, 3 = moderate disability, and 4 = severe disability). Overall, patients demonstrated a median improvement of 2 points in their Migraine Disability Assessment questionnaire score ($p < 0.0001$) (Table 6).

DISCUSSION

The costs associated with migraine headaches are multifaceted, comprising both direct and indirect costs. Previous reports have demonstrated the clinical efficacy of surgical deactivation of migraine trigger site.⁸⁻¹³ Despite the initial high costs associated with migraine surgery, this study dem-

onstrates that, over time, significant reductions in direct and indirect costs can occur.

Medical resource use for the treatment of migraine headaches is significant, with the fourth most common emergency room complaint being headaches.²³ Patients with migraine headaches generate nearly twice as many medical claims and nearly two and a half times as many pharmacy claims when compared with patients without migraine headaches.^{24,25} These patients use more diagnostic services and procedures, incurring an overall 64 percent greater health care cost. One-tenth (\$1.5 billion) of the estimated annual cost of migraine headaches treatment is spent toward pharmacotherapy.²⁶ Hawkins et al. reported the annual estimated cost burden attributed to migraine headache care to be \$2571 greater than for controls,²⁵ whereas others have estimated the annual direct cost of migraine treatment to be as high as \$7089 per patient²⁷ and the annual indirect cost to be as high as \$4453 per patient.⁸ We believe that patients in this study may have incurred the greatest cost possible, as those selected to undergo surgery typically had more frequent headaches and experienced more intense pain.

Table 6. Change in Migraine Disability Assessment Questionnaire Responses at 5 Years Postoperatively

	No.	1st Quartile	Median	3rd Quartile	<i>p</i>	95% CI
In the past 3 months, how many days did you... Miss work or school because of your headaches?	49	-1	-2	-5	<0.0001	-1.5 to -4.0
Feel your productivity was reduced by half or more because of your headaches?	67	-2	-8	-15	<0.0001	-6.0 to -10.6
Not do household work because of your headaches?	83	-2	-6	-15	<0.0001	-5.5 to -10.0
Feel your household productivity was reduced by half or more because of your headaches?	79	-2	-5	-12	<0.0001	-4.5 to -9.0
Miss family, social, or leisure activities because of your headaches?	70	-1	-3	-8	<0.0001	-2.75 to -5.5
Have a headache?*	81	-3.5	-15	-30	<0.0001	-12.5 to -23.0
On average, how painful were these headaches? (0-10 scale)†	87	0	-2	-4	<0.0001	-1.5 to -3.25
MIDAS questionnaire grade‡	87	0	-2	-3	<0.0001	-1.5 to -2.5

CI, confidence interval; MIDAS, Migraine Disability Assessment.

*If headache lasted more than 1 day, count each day.

†0 = no pain at all and 10 = pain as bad as it can be.

‡1 = little or no disability, 2 = mild disability, 3 = moderate disability, and 4 = severe disability.

The use of alternative treatments by patients with migraine headaches to complement traditional medical therapies may include Botox injections, massage therapy, acupuncture, biofeedback, and chiropractic services. The American Migraine Center reported that patients receive an average of 100 units of Botox four times per year, with a mean total reimbursement of \$954 per 100 units.²⁸ Although the use of Botox for refractory migraine headaches may improve patient quality of life, a managed care organization determined that pharmacy costs actually increased by 80.9 percent in patients who receive Botox injections for treatment of migraine headaches.²⁹

This study demonstrates that surgical deactivation of migraine trigger sites appears to result in a substantial cost savings for patients who suffer from migraine headaches. Data in this study are a more thorough analysis of the financial data reported in the original clinical trial.¹¹ As a result, the costs reported here include items that were not accounted for previously. Data gathered in this study are consistent with overall cost estimates from other studies, after taking into account the severity and frequency of migraine headaches in this population. We demonstrated that at 5 years postoperatively, patients have a significant reduction in time and money spent on the treatment of migraine headaches. After deactivation, patients can expect to spend less on drug therapy and alternative treatment modalities and may require fewer doctor and emergency room visits.

When analyzing the three questionnaires used in this study, patients showed an increase in the number of days spent at work and within the

household and had improvements in their overall productivity. Diminishing the number of work days missed and enhancing work productivity may result in improved indirect costs to employers, patients, and families during the peak years of productivity and child bearing. We demonstrated indirect cost improvements in all aspects of work except for those associated with childcare. The bimodal distribution of childcare costs may be explained by some postoperative patients requiring more childcare services with their return to work, whereas others used fewer childcare services secondary to their improved health status.

There were six patients who had overall cost increases. Two patients showed a decreased need for medication but an increased use of alternative treatments. Four patients increased their medication needs. Of the four patients who increased their medication use, two were documented by their neurologist to have either a medication addiction or rebound headaches from medication overuse. The remaining two patients had continued migraine symptoms.

We recognize a number of limitations to this study. We were unable to control for any changing costs of medication over time or changes associated with patient reimbursement plans or estimation of benefits within and between insurance plans. By reporting total costs rather than individualizing costs to the patient and costs to the insurance company, we attempted to eliminate interpatient and inpatient variations in insurance coverage over time. Over the duration of the study, certain medications such as Imitrex have become available in generic form, thus reducing costs. Although medical costs

are expected to be somewhat equivocal across the country, we recognize that the costs associated with alternative treatment such as massage and chiropractor visits also may vary across the country. We were unable to control for the inflation of costs associated with the other medical care and alternative treatment modalities over time. The cost of medication provided to patients as free samples was extrapolated to maintain consistency. Patients were encouraged to keep track of their use of treatment modalities, costs, and days missed from work, but we recognize the limitations associated with patient compliance and recall bias.

The current cost associated with the treatment of migraine headache is enormous. The results of this study demonstrate that the surgical deactivation of migraine trigger sites may be a cost-effective approach to the treatment of migraine headache. We have demonstrated both direct and indirect cost reductions.

CONCLUSIONS

Surgical deactivation of migraine headache trigger sites is an effective treatment modality for improving symptoms of migraine headache.^{9–14} This study illustrates that surgery for migraines is also a cost-effective treatment modality. The cost savings are demonstrated to be consistent over a 5-year period. The long-term cost savings associated with migraine surgery should be considered by patients and insurers.

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