Neurological Sciences (2019) 40:393–398
https://doi.org/10.1007/s10072-018-3661-2

ORIGINAL ARTICLE

# Clinical significance of sensory hypersensitivities in migraine patients: does allodynia have a priority on it?

Jong-Geun Seo[1] · Sung-Pa Park[1]

Received: 5 August 2018 / Accepted: 23 November 2018 / Published online: 1 December 2018


## Abstract

**Objectives** This study investigated to identify the clinical significance of allodynia compared with other sensory hypersensitivities (SH) in migraine patients.

**Methods** New patients with migraine were recruited from a headache clinic, and we collected data regarding their clinical characteristics and identified SH including photophobia, phonophobia, osmophobia, and allodynia. The patients completed the 12-item Allodynia Symptom Checklist, Migraine Disability Assessment Scale (MIDAS), Headache Impact Test-6 (HIT-6), Patient Health Questionnaire-9 (PHQ-9), Generalized Anxiety Disorder-7 (GAD-7), Insomnia Severity Index (ISI), Fatigue Severity Scale (FSS), and Migraine-Specific Quality of Life Questionnaire Version 2.1. We divided the patients into three groups: SH with allodynia (group 1), SH without allodynia (group 2), and no SH (group 3). Clinical characteristics, psychosomatic features, and quality of life (QOL) were compared among these groups.

**Results** A total of 312 migraine patients participated in the study. Among them, 58 (18.6%), 202 (64.7%), and 52 (16.7%) were allocated to groups 1, 2, and 3, respectively. Chronic migraine, family history of migraine, medication overuse headache, earlier age at onset, longer disease duration, higher headache intensity, and aggravation with physical activity were more prevalent in group 1 than in groups 2 or 3. Scores of the MIDAS, HIT-6, PHQ-9, GAD-7, ISI, and FSS were the highest in group 1, followed by groups 2 and group 3. The lowest QOL was noted in group 1, followed by groups 2 and group 3.

**Conclusions** This study revealed that SH in migraine, particularly combined with allodynia, may result in poor clinical outcomes.

**Keywords** Sensory hypersensitivity · Migraine · Allodynia · Quality of life · Poor outcome

## Introduction

Migraine is a disabling neurological disorder due to recurrent attacks of headache and accompanying psychosomatic symptoms such as depression, anxiety, sleep problems, and fatigue [1–3]. These symptoms can trigger migraine attacks, restrict daily activities, and affect the quality of life (QOL) [1, 3–5].

Migraine patients commonly experience sensory hypersensitivities (SH), which include photophobia, phonophobia, osmophobia, and allodynia during migraine attacks [3, 4, 6]. It has been known that SH reflects central sensitization at different levels by functional neuroimaging and electrophysiological studies [7]. Among SH in migraine, the clinical significance of allodynia has been commonly studied. Allodynia induces migraine chronification and high disability [8, 9] and is associated with migraine severity, occurrence of other SH, premonitory signs, aura, family history, depression, anxiety, sleep quality, and fatigue, as reported in population- and hospital-based studies [3, 6, 10–12].

Other SH may also have a clinical significance similar to that of allodynia considering that all SH have the same pathogenic mechanism. However, if the priority of allodynia for determining clinical significance exists, we should clarify it. Allodynia can be underrecognized in clinical setting as it is not a diagnostic criterion of migraine [13]. Therefore, we investigated the clinical significance of allodynia compared with that of other SH in migraine patients.

✉ Sung-Pa Park
sppark@mail.knu.ac.kr

Jong-Geun Seo
jonggeun.seo@gmail.com

[1] Department of Neurology, School of Medicine, Kyungpook National University, 680 Gukchaebosang-ro, Jung-gu, Daegu 41944, Republic of Korea

## Materials and methods

### Subjects

Subjects with new patients with migraine, aged 15–70 years were recruited from a headache clinic at Kyungpook National University Hospital from April 2015 to October 2017. Patients were diagnosed according to the International Classification of Headache Disorders, 3rd edition, beta version by a trained neurologist [13]. Patients with intellectual disability and severe medical, neurological, or psychiatric disorders that prevented them from understanding the self-report questionnaire were excluded. Patients with probable migraine and who refuse study participation were also excluded.

### Study design

This cross-sectional study was approved by the Institutional Review Board of Kyungpook National University Hospital, and all subjects gave written informed consent. Demographic, social, and clinical information of the subjects collected at enrollment. The sociodemographic variables were collected. The clinical variables included height and weight, concurrent medical disease, type of migraine, migraine chronicity, family history of migraine, medication overuse headache (MOH), age at onset, duration of migraine, attack duration, headache intensity, aggravation with physical activity, and accompanying symptoms (nausea and/or vomiting, photophobia, phonophobia, osmophobia, and allodynia). Maximal headache intensity in the preceding month was measured using the Visual Analog Scale (VAS). Photophobia, phonophobia, and osmophobia were defined as hypersensitivity to light, sound, and certain odors during migraine attack, respectively, by a clinical interview.

Eligible subjects completed several self-reported questionnaires, including the Headache Impact Test-6 (HIT-6) [14], Patient Health Questionnaire-9 (PHQ-9) [15], the Generalized Anxiety Disorder-7 (GAD-7) [16], Korean version of Perceived Stress Scale (PSS) [17], Epworth Sleepiness Scale (ESS) [18], Insomnia Severity Index (ISI) [19], Fatigue Severity Scale (FSS) [20], and Korean Migraine-Specific Quality of Life Questionnaire Version 2.1 (K-MSQ) [21].

### Questionnaires

#### Allodynia Symptom Checklist (ASC-12)

The ASC-12 is a self-administered questionnaire regarding cutaneous allodynia with scores ranging from 0 to 24 points: no allodynia (0–2 points), mild (3–5 points), moderate (6–8 points), and severe (9 or more points). Patients who had more than 2 points in the ASC-12 were considered as having allodynia [8]. We divided patients into three groups: those having SH with allodynia (group 1), SH without allodynia (group 2), and no SH (group 3).

#### Headache Impact Test-6 (HIT-6)

The HIT-6 measures a wider spectrum of headache-related burden. The HIT-6 includes six items and each item is answered using a 5-point Likert scale (6 = never, 8 = rarely, 10 = sometimes, 11 = very often, 13 = always). The total score can range from 36 to 78; larger scores indicate a greater impact. Scores of 60 or higher indicate a severe impact [22]. The Korean version of the HIT-6 has been validated and Cronbach's $\alpha$ was 0.85 [14].

#### Patient Health Questionnaire-9 (PHQ-9)

The PHQ-9 was designed for the diagnosis of major depressive disorder (MDD) over the prior 2 weeks. It includes nine items and each item is rated on a 4-point scale from 0 to 3. The overall score can range from 0 to 27 and a cutoff score of 7 indicates MDD [15]. The PHQ-9 can be downloaded for free on the PHQ website (http://www.phqscreeners.com/) [23]. The Korean version of the PHQ-9 has been validated in patients with migraine, and Cronbach's $\alpha$ was 0.89 [15].

#### Generalized Anxiety Disorder-7 (GAD-7)

The GAD-7 was designed for diagnosis of generalized anxiety disorder (GAD) over the prior 2 weeks. It includes seven items and each item is rated on a 4-point scale from 0 to 3. The overall score can range from 0 to 21 and a cutoff score of 5 indicates GAD. The GAD-7 can be downloaded for free on the Patient Health Questionnaire website (www.phqscreeners.com) [24]. The Korean version of the GAD-7 has been validated in patients with migraine, and Cronbach's $\alpha$ was 0.92 [16].

#### Insomnia Severity Index (ISI)

The ISI is a 7-item questionnaire that measures a patient's perception of insomnia severity [19]. Each ISI item is rated on a scale of 0–4. Its total score ranges from 0 to 28, with a higher score indicating greater insomnia severity. The Korean version of the ISI has been validated in patients with sleep disorders [19]. A cutoff score of 15.5 has been suggested for discriminating patients with insomnia. Cronbach's $\alpha$ coefficient of ISI was 0.92.

#### Fatigue Severity Scale (FSS)

The FSS consists of nine items that assess fatigue on a scale from 0 to 7 [20]. After summing the scores of the nine items, the total score is divided by 9, yielding values from 0 to 7. The

**Table 1** Characteristics of migraine patients according to the existence of sensory hypersensitivities

| Characteristics | Mean ± SD (range) or number (%) | | | | | |
|---|---|---|---|---|---|---|
| | SH with allodynia[a] ($n = 58$) | SH without allodynia[b] ($n = 202$) | No SH[c] ($n = 52$) | $F$ or $\chi^2$ | $p$ value* | Post hoc |
| Age, years | 42.0 ± 12.3 (16–68) | 40.6 ± 13.5 (15–65) | 43.1 ± 13.8 (17–65) | 0.794 | 0.453 | |
| Gender, female | 51 (87.9) | 162 (80.2) | 43 (82.7) | 1.847 | 0.438 | |
| Education, years | 12.9 ± 2.7 (6–18) | 12.9 ± 3.1 (3–20) | 12.9 ± 3.2 (6–18) | 0.004 | 0.996 | |
| BMI | 22.2 ± 3.4 (15–35) | 22.8 ± 3.4 (18–36) | 22.1 ± 2.7 (17–29) | 1.368 | 0.256 | |
| Type of migraine | | | | 2.799 | 0.243 | |
| Migraine with aura | 2 (3.4) | 20 (9.9) | 6 (11.5) | | | |
| Migraine without aura | 56 (96.6) | 182 (90.1) | 46 (88.5) | | | |
| Migraine chronicity | | | | 22.055 | < 0.001 | |
| Episodic migraine | 17 (29.3) | 122 (60.4) | 36 (69.2) | | | $a < b, c$ |
| Chronic migraine | 41 (70.7) | 80 (39.6) | 16 (30.8) | | | $b, c < a$ |
| Family history of migraine | 43 (74.1) | 131 (64.9) | 26 (50.0) | 7.082 | 0.03 | |
| Medication overuse headache | 13 (22.4) | 20 (9.9) | 4 (7.7) | 7.786 | 0.032 | |
| Age at onset, years | 28.3 ± 11.6 (8–50) | 29.4 ± 12.5 (6–58) | 34.4 ± 12.8 (14–60) | 4.009 | 0.019 | $a, b < c$ |
| Disease duration, years | 13.5 ± 8.9 (0.3–33) | 11.2 ± 9.2 (0.3–42) | 8.7 ± 8.8 (0.4–42) | 3.951 | 0.02 | $c < a$ |
| VAS | 8.6 ± 1.3 (5–10) | 7.2 ± 2.4 (0–10) | 7.1 ± 2.5 (0–10) | 8.393 | < 0.001 | $b, c < a$ |
| Aggravation by physical activity | 50 (86.2) | 123 (60.9) | 23 (44.2) | 21.597 | < 0.001 | $c < b < a$ |
| Nausea and/or vomiting | 48 (82.8) | 174 (86.1) | 46 (88.5) | 0.764 | 0.704 | |
| MIDAS, days | 40.7 ± 33.6 (0–180) | 20.9 ± 25.6 (0–181) | 15.8 ± 21.2 (0–120) | 15.282 | < 0.001 | $b, c < a$ |
| HIT-6 | 62.3 ± 7.6 (45–78) | 57.7 ± 7.6 (38–78) | 55.0 ± 8.0 (38–76) | 13.243 | < 0.001 | $b, c < a$ |
| PHQ-9 | 10.6 ± 6.1 (2–27) | 5.9 ± 4.5 (0–27) | 4.2 ± 4.4 (0–16) | 27.919 | < 0.001 | $b, c < a$ |
| GAD-7 | 7.6 ± 6.2 (0–21) | 4.7 ± 4.4 (0–21) | 3.1 ± 3.6 (0–16) | 13.583 | < 0.001 | $b, c < a$ |
| ISI | 12.5 ± 6.7 (0–26) | 8.3 ± 5.6 (0–26) | 6.2 ± 5.3 (0–19) | 18.216 | < 0.001 | $c < b < a$ |
| FSS | 4.4 ± 1.6 (1–7) | 3.4 ± 1.5 (1–7) | 3.4 ± 1.5 (1–7) | 11.363 | < 0.001 | $b, c < a$ |

*SH* sensory hypersensitivities, *BMI* body mass index, *VAS* visual analog scale, *MIDAS* Migraine Disability Assessment Scale, *HIT-6* Headache Impact Test-6, *PHQ-9* Patient Health Questionnaire-9, *GAD-7* Generalized Anxiety Disorder-7, *ESS* Epworth Sleepiness Scale, *ISI* Insomnia Severity Index, *FSS* Fatigue Severity Scale

*Fisher's exact test or analysis of variance was applied to compare three groups. The Bonferroni correction was used for post-hoc comparisons

FSS is useful in clinical practice because it has fewer items than other questionnaires that evaluate fatigue and it is easy to score. The Cronbach's $\alpha$ coefficient of the Korean version of the FSS is 0.935, and a total score of 3.22 or more is suggestive of pathologic fatigue [20].

### Migraine-Specific Quality of Life Questionnaire version 2.1 (MSQ)

The MSQ v. 2.1 measures the impact of migraine on QOL over the prior 4 weeks across three dimensions; Role Function-Restrictive (RF-R), Role Functional-Preventive (RF-P), and Emotional Function (EF) [21]. The MSQ v. 2.1 consists of 14 questions, 7 questions in the RF-R dimension, 4 questions in the RF-P dimension, and 3 questions in the EF dimension. Each question is rated on a 6-point scale from 1 to 6. The dimension scores are summed and rescaled to give a total score between 0 and 100. Higher scores in the MSQ indicate a better QOL state.

### Statistical analyses

The Statistical Package for the Social Sciences (SPSS version 21.0) was used for data analysis. Descriptive statistics are presented as counts, percentages, means, and standard deviations. Fisher's exact test or analysis of variance was applied to compare the three groups. The Bonferroni correction was used for post hoc comparisons. The level of statistical significance was set at $p < 0.05$.

## Results

A total of 391 consecutive patients with migraine visited the clinic during the study. Among them, 79 patients were excluded for the following reasons: refusal to complete the questionnaires ($n = 41$); probable migraine ($n = 26$); illiteracy ($n = 6$); or age older than 70 ($n = 6$). Subsequently, 312 patients

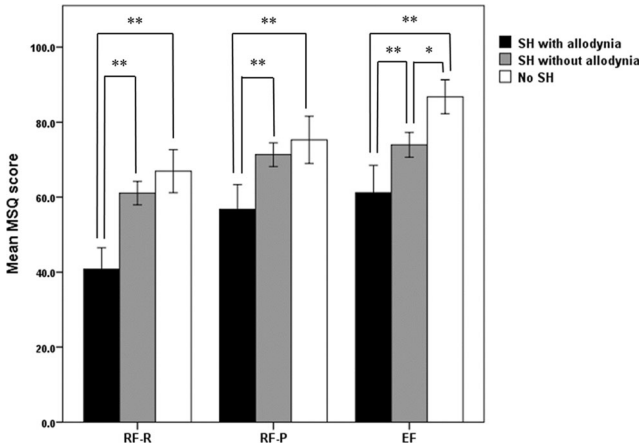


**Fig. 1** Comparison of the mean MSQ score among patients who had SH with allodynia ($n = 58$), SH without allodynia ($n = 202$), and no SH ($n = 52$). Three dimensional scores of the MSQ were significantly different between groups. Error bars represent 95% confidence intervals. Analysis of variance and post-hoc comparisons with the Bonferroni correction were applied to measure the differences. $^{*}p < 0.01$, $^{**}p < 0.001$. MSQ Migraine-Specific Quality of Life Questionnaire version 2.1, SH sensory hypersensitivities, RF-R role function-restrictive, RF-P role function-preventive, EF emotional function

completed the study. Among these patients, photophobia, phonophobia, osmophobia, and allodynia were manifested in 157 (50.3%), 194 (62.2%), 149 (47.8%), and 58 (18.6%), respectively.

The characteristics of migraine patients according to the existence of SH are demonstrated in Table 1. Among patients, 58 (18.6%), 202 (64.7%), and 52 (16.7%) were allocated to groups 1, 2, and 3, respectively. Among 58 allodynic patients, allodynic symptoms were mild in 34 (58.6%), moderate in 10 (17.2%), and severe in 14 (24.1%). Age, gender, and education among the groups were not different. However, significant group differences were denoted in migraine chronicity, family history of migraine, MOH, age at onset, disease duration, headache intensity, aggravation with physical activity, and scores of the MIDAS, HIT-6, PHQ-9, GAD-7, ISI, and FSS. In post hoc comparisons, the frequency of chronic migraine (CM) was significantly higher in group 1 than in groups 2 or 3. The frequency of aggravation with physical activity was the highest in group 1, followed by groups 2 and 3. Age at onset was significantly higher in group 3 than groups 1 or 2. Disease duration was significantly longer in group 1 than group 3. Scores of the VAS, MIDAS, HIT-6, PHQ-9, GAD-7, and FSS were significantly higher in group 1 than groups 2 or 3. The ISI score was the highest in group 1, followed by groups 2 and 3.

The MSQ scores by the presence of SH are demonstrated in Fig. 1. Scores of the RF-R and RF-P dimensions were significantly lower in group 1 than in groups 2 or 3. The EF dimension score was the lowest in group 1, followed by groups 2 and 3.

## Discussion

This study revealed that SH with allodynia was frequently observed in patients with CM, family history of migraine, MOH, earlier age at onset, longer disease duration, higher headache intensity, and aggravation by physical activity. The degree of depression, anxiety, insomnia, fatigue, and headache-related disability were significantly higher in patients having SH with allodynia than in other patients. In addition, patients having SH with allodynia showed a significantly reduced QOL compared with those having SH without allodynia or no SH.

Patients with migraine had increased sensitivity to visual, auditory, and olfactory stimuli. Although allodynia was not included in the diagnostic criteria, recent several studies have emphasized the somatosensory system (allodynia) in migraine patients [8, 25, 26]. Similar to previous studies, our study indicates that allodynia is more frequent in CM than episodic migraine (EM) [27]. It is also associated with the disease duration and inadequate treatment response [27, 28]. In addition, patients with allodynia tend to have more severe headache-related disabilities than those without allodynia [8, 29]. This association may explain the present findings that MOH and higher headache intensity were observed in patients having SH with allodynia than those without allodynia.

Several studies have investigated the relationship between allodynia and psychiatric comorbidities in migraine patients. Previous studies have reported that depression was a risk factor for allodynia, and that the degree of depressive symptoms is associated with the severity of allodynia [8, 30]. In addition, allodynia was associated with anxiety in migraine patients [6]. This study showed similar results in that the degree of depression and anxiety symptoms was significantly higher in patients having SH with allodynia than in those without allodynia. This study also showed that the presence of SH with allodynia was associated with the severity of insomnia and fatigue. Some studies have revealed that allodynia was associated with poor sleep quality and chronic fatigue syndrome (CFS) [12, 31]. The relationship between allodynia and sleep quality may be bidirectional. Allodynia may induce insomnia or frequent wakening during sleep, and poor sleep quality may influence allodynia onset by central sensitization mechanisms [12]. The presence of allodynia was related with an increased risk of irritable bowel syndrome, fibromyalgia, and CFS [31]. This relationship may explain the hypothesis that central sensitization is a pathophysiological link [31].

Our study investigated the relationship between SH and QOL in migraine patients. Patients having SH with allodynia showed a significantly reduced QOL compared with those without allodynia. This is a meaningful result that the presence of allodynia had a negative effect on the QOL in this study.

This study has some limitations. First, eligible subjects were recruited from a single tertiary hospital; therefore, the results cannot be generalized. Second, we did not confirm

the presence of headache at the moment of the examination. Because allodynia can be present during the ictal phase, irrespective of headache chronicity, the concurrent headache should be considered a critical factor for allodynia. Third, ethnic differences could also limit the generalization of our results; for example, our patients revealed a lower frequency of allodynia than Western patients did. In addition, more than half of allodynic patients in our study exhibited mild symptoms. Further studies to validate our results should be conducted in Western countries. Fourth, we asked patients about SH during migraine attacks. However, those symptoms can also occur between migraine attacks. Interictal symptoms may induce different results regarding clinical significance.

## Conclusions

Migraine patients exhibit increased responsiveness to sensory stimuli, which is explained by central sensitization. Although allodynia is not a diagnostic criterion of migraine, this study showed that the presence of SH with allodynia was significantly associated with clinical variables, psychosomatic symptoms, and impaired QOL in migraine patients. As SH with allodynia may reflect a poor clinical outcome of migraine, it would be better for clinicians to cope actively with it.

**Acknowledgements** The authors thank Ju-Hui Lee, a neuropsychologist, for her help with the completion of self-report questionnaires.

### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no competing interests.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

## References

1. Lipton RB, Stewart WF, Diamond S, Diamond ML, Reed M (2001) Prevalence and burden of migraine in the United States: data from the American migraine study II. Headache 41(7):646–657
2. Minen MT, Begasse De Dhaem O, Kroon Van Diest A, Powers S, Schwedt TJ, Lipton R, Silbersweig D (2016) Migraine and its psychiatric comorbidities. J Neurol Neurosurg Psychiatry 87(7):741–749
3. Seo JG, Park SP (2018) Significance of fatigue in patients with migraine. J Clin Neurosci 50:69–73
4. Kim SY, Park SP (2014) The role of headache chronicity among predictors contributing to quality of life in patients with migraine: a hospital-based study. J Headache Pain 15(1):68
5. Park JW, Chu MK, Kim JM, Park SG, Cho SJ (2016) Analysis of trigger factors in episodic migraineurs using a smartphone headache diary applications. PLoS One 11(2):e0149577
6. Kao CH, Wang SJ, Tsai CF, Chen SP, Wang YF, Fuh JL (2014) Psychiatric comorbidities in allodynic migraineurs. Cephalalgia 34(3):211–218
7. Demarquay G, Mauguière F (2016) Central nervous system underpinnings of sensory hypersensitivity in migraine: insights from neuroimaging and electrophysiological studies. Headache 56(9):1418–1438
8. Lipton RB, Bigal ME, Ashina S, Burstein R, Silberstein S, Reed ML, Serrano D, Stewart WF, American Migraine Prevalence Prevention Advisory Group (2008) Cutaneous allodynia in the migraine population. Ann Neurol 63(2):148–158
9. Louter MA, Bosker JE, van Oosterhout WP, van Zwet EW, Zitman FG, Ferrari MD, Terwindt GM (2013) Cutaneous allodynia as a predictor of migraine chronification. Brain 136(Pt 11):3489–3496
10. Kim SY, Park SP (2016) Cutaneous allodynia and its risk factors in Korean patients with migraine: a survey of two tertiary care hospitals. J Oral Facial Pain Headache 30(4):323–329
11. Baykan B, Ekizoglu E, Karli N, Kocasoy-Orhan E, Zarifoglu M, Saip S, Siva A, Ertas M (2016) Characterization of migraineurs having allodynia: results of a large population-based study. Clin J Pain 32(7):631–635
12. Lovati C, D'Amico D, Bertora P, Raimondi E, Rosa S, Zardoni M, Bussone G, Mariani C (2010) Correlation between presence of allodynia and sleep quality in migraineurs. Neurol Sci 31(Suppl 1):S155–S158
13. Headache Classification Committee of the International Headache Society (IHS) (2013) The international classification of headache disorders, 3rd edition (beta version). Cephalalgia 33(9):629–808
14. Chu MK, Im HJ, Ju YS, Yu KH, Ma HI, Kim YJ, Kim J, Lee BC (2009) Validity and reliability assessment of Korean Headache Impact Test-6 (HIT-6). J Korean Neurol Assoc 27(1):1–6
15. Seo JG, Park SP (2015) Validation of the Patient Health Questionnaire-9 (PHQ-9) and PHQ-2 in patients with migraine. J Headache Pain 16:65
16. Seo JG, Park SP (2015) Validation of the Generalized Anxiety Disorder-7 (GAD-7) and GAD-2 in patients with migraine. J Headache Pain 16:97
17. Lee J, Shin C, Ko YH, Lim J, Joe SH, Kim S, Jung IK, Han C (2012) The reliability and validity studies of the Korean version of the Perceived Stress Scale. Korean J Psychosom Med 20(2):127–134
18. Cho YW, Lee JH, Son HK, Lee SH, Shin C, Johns MW (2011) The reliability and validity of the Korean version of the Epworth sleepiness scale. Sleep Breath 15(3):377–384
19. Cho YW, Song ML, Morin CM (2014) Validation of a Korean version of the insomnia severity index. J Clin Neurol 10(3):210–215
20. Chung KI, Song CH (2001) Clinical usefulness of fatigue severity scale for patients with fatigue, and anxiety or depression. Korean J Psychosom Med 9(2):164–173
21. Seo JG, Park SP (2017) Validation of the Korean Migraine-Specific Quality of Life Questionnaire version 2.1 in episodic and chronic migraine. J Oral Facial Pain Headache 31(3):251–256
22. Bayliss M, Batenhorst A (2002) The HIT-6™ a user's guide. Quality Metric Incorporated, Lincoln
23. Pfizer. Patient Health Questionnaire (PHQ) screeners. http://www.phqscreeners.com/. Accessed Sep 2013
24. Pfizer. Patient Health Questionnaire (PHQ) screeners. http://www.phqscreeners.com/. Accessed Nov 2012

25. Burstein R, Yarnitsky D, Goor-Aryeh I, Ransil BJ, Bajwa ZH (2000) An association between migraine and cutaneous allodynia. Ann Neurol 47(5):614–624
26. Mathew NT, Kailasam J, Seifert T (2004) Clinical recognition of allodynia in migraine. Neurology 63(5):848–852
27. Benatto MT, Florencio LL, Carvalho GF, Dach F, Bigal ME, Chaves TC, Bevilaqua-Grossi D (2017) Cutaneous allodynia is more frequent in chronic migraine, and its presence and severity seems to be more associated with the duration of the disease. Arq Neuropsiquiatr 75(3):153–159
28. Lipton RB, Munjal S, Buse DC, Bennett A, Fanning KM, Burstein R, Reed ML (2017) Allodynia is associated with initial and sustained response to acute migraine treatment: results from the American Migraine Prevalence and Prevention Study. Headache 57(7):026–1040
29. Antonaci F, Nappi G, Galli F, Manzoni GC, Calabresi P, Costa A (2011) Migraine and psychiatric comorbidity: a review of clinical findings. J Headache Pain 12(2):1–11
30. Mendonça MD, Caetano A, Viana-Baptista M, CHLO Headache Study Group (2016) Association of depressive symptoms with allodynia in patients with migraine: aA cross-sectional study. Cephalalgia 36(11):1077–1081
31. Tietjen GE, Brandes JL, Peterlin BL, Eloff A, Dafer RM, Stein MR, Drexler E, Martin VT, Hutchinson S, Aurora SK, Recober A, Herial NA, Utley C, White L, Khuder SA (2009) Allodynia in migraine: association with comorbid pain conditions. Headache 49(9):1333–1344