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Research report

Biological rhythm differences and suicidal ideation in patients with major depressive disorder

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ABSTRACT

Background: Suicidal behavior has been reported to be associated with seasonality and chronotype. However, no study has reported the suicidality according to chronotype and seasonality in patients with major depressive disorder (MDD). This study evaluated the relationship of suicidality and biological rhythm in patients with MDD.

Methods: A total of 120 patients with MDD participated. We evaluated their seasonal patterns, chronotypes (morningness, wake up early and are at their best during the first part of the day; eveningness, feel best and most alert during late hours), suicidal ideations, and other clinical variables including symptom severity.

Results: Patients with seasonality showed significantly higher suicidal ideation than patients without seasonality. Compared to morning-type participants, the evening-type participants showed higher suicidality. Suicidal ideation was positively correlated with eveningness tendencies and hypomanic personality traits.

Limitations: First, we did not analyze the causal relationship between biological rhythm and suicidality. Secondly, suicidal ideation does not in most cases reflect an actual attempt. Lastly, we did not categorize seasonal pattern into summer or winter type.

Conclusions: Our findings suggest that biological rhythm is significantly associated with suicidal ideation in patients with MDD.

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1. Introduction

Seasonal affective disorder (SAD) has been defined as a syndrome in which depressive symptoms develop during the winter season and remit in the summer season, respectively or vice versa (Rosenthal et al., 1984). The estimated lifetime prevalence of SAD is about 0.4% in the general population, and if minor depression is included, it is estimated as 1% (Partonen and Lonnqvist, 1998).

There may be several biological mechanisms underlying SAD (Rohan et al., 2009), including circadian phase delay (Lewy et al., 1987). Circadian rhythm has been regarded as a core feature of SAD (Kurlansik and Ibay, 2012). In addition, diurnal variation such as morningness–eveningness is another important biological rhythm. Morningness–eveningness is the difference in individual diurnal preference observed from general behavioral rhythms such as sleep habits (Smith et al., 1989). Generally, evening-type

individuals tend to keep late hours and also have an irregular sleeping pattern (Taillard et al., 1999). Morningness has been considered as a factor which decreases depressive symptoms in patients with major depressive disorder (MDD) (Selvi et al., 2010). In terms of biological differences, morning-type individuals had higher cortisol level than evening-types when cortisol level was measured after awakening (Randler and Schaal, 2010). Also, melatonin peak time was faster after sleep onset in morning-type individual than evening-type individuals (Liu et al. 2000). It has been suggested that eveningness is related to seasonality of mood because both traits are associated with an abnormal delay of the circadian phase (Murray et al., 2003). Natale et al. (2005) found a significant correlation between the eveningness and seasonality in healthy populations.

Suicidal behavior is known to be significantly associated with seasonality and circadian rhythm. Previous studies reported that the incidence of suicide peaks during spring (Altamura et al., 1999, Lambert et al., 2003, Christodoulou et al., 2012). Aydin et al. (2013) found that self-destructive behaviors are closely related with seasonality. In addition, particularly violent suicidal behavior also

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shows seasonality, which reflects possible influence on violent suicidal behavior via biological rhythms (Preti and Miotto, 1998, Lambert et al., 2003, Rock et al., 2003, Christodoulou et al., 2012). One study reported that peak numbers of suicides occur in the forenoon (Altamura et al., 1999). Usually evening-type persons showed more suicidality (Lee et al., 2009), behavioral/emotional problems, and habitual substance use than morning and intermediate groups (Gau et al., 2007). Evening-type suicide attempters reported significantly higher impulsivity scores than morning types (Selvi et al., 2011). Verkes et al. (1996) reported that the non-circadian periodicity (abnormal rhythm) group showed significantly higher suicidal ideation and impulsivity (Verkes et al., 1996).

However, no previous study has reported suicidality according to chronotype and seasonal pattern in patients with major depressive disorder (MDD). We hypothesized that within patients with MDD, those with seasonal pattern or the evening-type would demonstrate higher suicidal ideation than those without them, respectively.

2. Methods

2.1. Participants

A total of 120 patients with MDD were recruited for this study (18 to 74 years old, 81.66% female). They were recruited from the Department of Psychiatry, Ilsan Paik University College of Medicine. All the patients were diagnosed using the Statistical Manual of Mental Disorders, 4th edition (Association, 2000) by two board certified psychiatrists. All patients with MDD were in drug naïve state at least during 2 weeks. Exclusion criteria included the presence of any identifiable neurological disorder, head injury, mental retardation, alcohol or substance abuse, other identifiable psychiatric disorders except MDD, and any physical illness that can affect cognitive function or cause hearing loss. The study protocol was approved by the Institutional Review Board of Inje University Ilsan Paik Hospital.

After being informed of the details of the study, all subjects provided their written informed consent prior to participation. The demographics of the two groups are provided in Table 1; there were no significant group differences with regard to gender distribution, age, education, or symptom severity of depression and anxiety.

Table 1
Demographic and clinical characteristics of patients with major depressive disorder, with and without seasonal affective disorder.

	SAD (<i>n</i> =30) Mean (SD)	Non-SAD (<i>n</i> =90) Mean (SD)	<i>t</i> (χ^2)	<i>df</i>	<i>p</i>
Age (years)	39.07 (14.48)	43.43 (13.65)	1.49	118	0.138
Sex (male:female)	8:22	14:76	1.85*	1	0.173
Education (years)	12.55 (3.30)	12.48 (3.51)	-0.93	116	0.926
HAM-D	30.27 (6.35)	28.53 (6.51)	-1.27	118	0.206
HAM-A	24.63 (6.13)	24.36 (5.75)	-0.23	118	0.822
BSI	16.23 (8.03)	9.81 (8.02)	-3.80	118	0.000
Behavioral inhibition	19.83 (2.38)	19.13 (2.88)	-1.20	118	0.232
Behavioral activation	33.87 (6.90)	32.84 (5.54)	-0.82	118	0.413
HPS	23.80 (7.21)	21.08 (7.98)	-1.66	118	0.100
MEQ	29.57 (7.86)	34.32 (8.28)	2.76	118	0.007

Note: *, χ^2 ; HAM-D, Hamilton Depression Rating Scale; HAM-A, Hamilton Anxiety Rating Scale; BSI, Beck scale for Suicidal Ideation; BIS, Behavioral Inhibition System; BAS, Behavioral Activation System; HPS, Hypomania Personality Scale; MEQ, Morningness–Eveningness Questionnaire.

2.2. Psychological measures

To assess seasonality pattern, the Seasonal Pattern Assessment Questionnaire (SPAQ) developed by Rosenthal (1987) was used to investigate mood and behavioral changes with the seasons (Rosenthal et al., 1987). The global seasonality score ranged between 0 and 24. If an individual has both a global seasonality score of 10 or more and reports at least moderate problems with seasonal changes, the individual is classified as having SAD. For classification as subsyndromal-SAD, [1] a global seasonality score of 10 or above, but mild or no problems with seasonal changes; or [2] global seasonality score of 8 or 9, and having a moderate or worse problem with seasonal changes (Kasper et al., 1989). In this study, we take SAD as all of winter, summer and subsyndromal SAD. SPAQ shows good internal consistency (Cronbach's alpha =0.81) and test–retest reliability (0.76) (Young et al., 2003).

The Morningness–Eveningness Questionnaire (MEQ) developed by Smith et al. (1989) was used to measure chronotype. It is composed of 13 items, three items on a 5-point scale items and ten items on a 4-point scale. The criteria for classification is under a score of 28 for evening-type and over a score of 41 for morningness-type. It has good split-half reliability (0.85), test–retest reliability (0.91), and internal consistency (Cronbach's alpha =0.82) in Korean samples (Smith et al., 1989, Yoon et al., 1997).

All participants were evaluated for severity of depressive and anxiety symptoms with the Hamilton Rating Scale for Depression (HAM-D) (Hamilton, 1960) and Hamilton Rating Scale for Anxiety (HAMA) (Hamilton, 1959). The Beck scale for Suicidal Ideation (BSI) developed by Beck et al. (1988) had been widely used to assess suicidal intention. It has good internal consistency (0.74) and moderately high correlations with other suicidal and hopeless scales in Korean samples (Lee and Kwon, 2009). The Behavioral Inhibition System and Behavioral Activation System (BIS/BAS) scales (Carver and White, 1994), also used, display good internal consistency (0.78) and test–retest reliability (0.79) in Korean samples (Kim and Kim, 2001). The final psychological measure we used—the Hypomanic Personality Scale (HPS)—also has good internal consistency (Cronbach's alpha =0.87). If an individual got above 36 scores, the individual is regarded as having hypomanic personality (Eckblad and Chapman, 1986).

2.3. Statistical analysis

SPSS 22 was used for statistical analysis. Chi-square tests were used for the analysis of categorical variables. Independent sample *t*-tests were used to compare scores of demographic and clinical data between groups. We used Pearson's correlation to investigate the relationship among clinical variables. The Bootstrap resampling technique (*n*=5000) was used to correct the multiple correlation. The significance level was set at *p* < 0.05.

3. Results

Thirty participants were classified to be in the SAD group (13 winter SAD, 8 summer SAD, 9 subsyndromal SAD; mean age 39.07, 73% female) and 90 participants belonged to the non-SAD group (mean age 43.43, 84% female). There were no significant differences between SAD/non-SAD groups in demographics such as age, sex and education level. However, there were significant differences in suicidal ideation (BSI score, 16.23(8.03) vs. 9.81(8.02), *t* = -3.80, *df* = 118, *p* < 0.001) and chronotype (MEQ score, 29.57(7.86) vs 34.32(8.28), *t* = 2.76, *df* = 118, *p* = 0.007) between the two groups. The SAD group showed significantly higher levels of suicidal ideation and a significant difference in the chronotype with more eveningness

than the non-SAD group. Demographics and clinical characteristics of SAD/non-SAD group are listed in Table 1.

Furthermore, we split the participants into two groups, morningness and eveningness. The morning-type group comprised of 25 participants (mean age 51.84, 76% female) and the evening-type group comprised 37 participants (mean age 32.73, 78% female). There were significant differences between morningness/evening-type groups in age (51.84(14.82) vs 32.73(10.26), $t=6.00$, $df=60$, $p<0.001$) and education level (11.08(4.78) vs 12.95(2.13), $t=-2.09$, $df=60$, $p=0.041$) but not in sex ratio. The evening-type group, compared to the morningness-type group, showed significantly higher BSI scores (6.00(7.84) vs 14.73(7.51), $t=-4.41$, $df=60$, $p<0.001$) and HPS scores (18.68(8.16) vs 24.70(7.40), $t=-3.01$, $df=60$, $p=0.004$). Because there were significant group differences in age and education level, additional analysis was conducted to control age and education level as covariates. However, there were still no changes of statistical significance in between the two groups. Demographics and clinical characteristics of morningness/evening-type groups are listed in Table 2.

There were significant correlations between BSI and other clinical variables such as HAM-D ($r=0.215$, $p=0.019$), HPS ($r=0.188$, $p=0.041$) and MEQ ($r=-0.204$, $p=0.026$) (Fig. 1).

4. Discussion

Our study aimed to find the relationship between suicidality and biological rhythm in patients with MDD. As hypothesized, the results

Table 2
Demographic and clinical characteristics of patients with major depressive disorder, in morning and evening type.

	Morning type (n=25) Mean (SD)	Evening type (n=37) Mean (SD)	t (χ^2)	df	p
Age (years)	51.84 (14.82)	32.73 (10.26)	6.00	60	0.000
Sex (male: female)	6:19	8:29	0.05*	1	0.826
Education (years)	11.08 (4.78)	12.95 (2.13)	-2.09	60	0.041
HAM-D	29.20 (6.21)	30.14 (6.97)	-0.54	60	0.590
HAM-A	23.44 (6.54)	25.16 (5.12)	-1.16	60	0.250
BSI	6.00 (7.84)	14.73 (7.51)	-4.41	60	0.000
BIS	18.28 (2.46)	19.59 (3.46)	-1.64	60	0.106
BAS	33.52 (5.28)	34.78 (7.56)	-0.72	60	0.472
HPS	18.68 (8.16)	24.70 (7.40)	-3.01	60	0.004

Note: * χ^2 ; HAM-D, Hamilton Depression Rating Scale; HAM-A, Hamilton Anxiety Rating Scale; BSI, Beck scale for Suicidal Ideation; BIS, Behavioral Inhibition System; BAS, Behavioral Activation System; HPS, Hypomania Personality Scale.

showed that the SAD group had significantly higher suicidal ideation than the non-SAD group. Compared to the morning-type group, the evening-type group showed higher suicidal ideation. In addition, suicidal ideation was positively correlated with eveningness tendency and hypomanic personality traits.

There was significant difference in suicidal ideation between the SAD and non-SAD groups, even though there were no significant differences in depression and anxiety symptoms. There have been numerous studies about seasonal patterns of suicidal behavior. Altamura et al. (1999) analyzed suicides in Cagliari from 1990 to 1994, and found that suicide behavior peaked during spring. Aydin et al. (2013) analyzed 1448 cases of the completed and attempted suicides in a 3-year time period and found that self-destructive behavior related to suicide attempt peaked in the autumn among individuals who had psychological problems. Another previous study analyzed all suicide in Italy in the period 1984–1995 and found that particularly violent suicide shows clear evidence of seasonality, with a peak in spring and a low in late autumn (Preti and Miotto, 1998). Previous researches have addressed an epidemiological factor of suicidal behavior or association between seasonality and violent suicidal behavior. Our present results are in line with the results of these previous nonclinical cohort studies. Our results indicate that seasonality is an important independent variable which can be associated with suicidality in depressive patients.

We also found that chronotype is associated significantly with suicidal ideation. The evening-type group has higher suicidal ideation compared to the morning-type group. A previous study which included 89 suicide attempters reported that the evening-type subjects had more suicidality than both morningness and intermediate subjects (Selvi et al., 2011). Natale et al. (2005) reported a significant correlation between the eveningness score and the seasonality score in 1715 healthy subjects from Spain. Consistent with previous studies, our present study revealed that SAD group patients show higher eveningness tendencies than non-SAD group patients. It suggests both seasonality and eveningness are related to abnormal delays of the circadian phase. Thus, our findings indicate that biological rhythm dysfunction is associated with suicidality.

Lastly, our study showed that suicidal ideation was positively correlated with severity of depressive symptoms, eveningness tendencies and hypomanic personality traits. In previous studies of chronotype, Gau et al. (2007) reported that there was positive correlation between eveningness chronotype and suicidal ideation in 1332 adolescents. In Korean subjects, Lee et al. (2009) also found similar results for 1000 healthy participants. Our findings are in agreement with previous findings and suggest that eveningness chronotype can be a risk factor of suicide in patients with MDD.

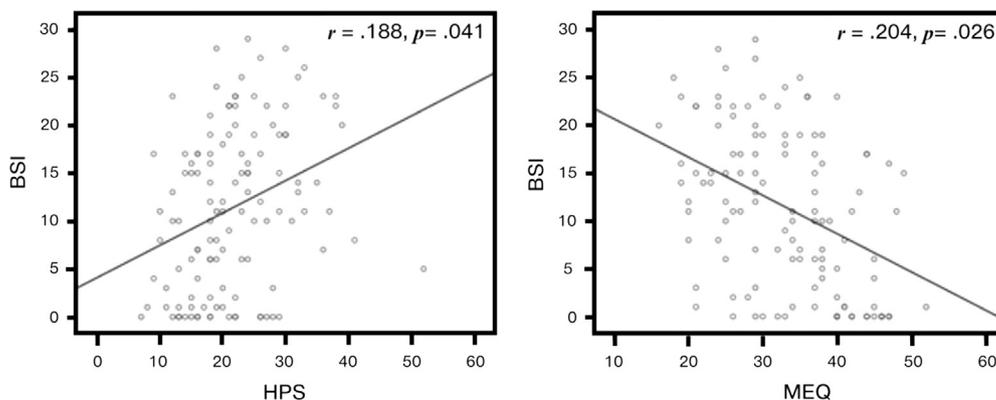


Fig. 1. Pearson correlation between BSI and other clinical variables. Note: BSI, Beck scale for Suicidal Ideation; HPS, Hypomania Personality Scale; MEQ, Morningness Eveningness Questionnaire

Our results showed that hypomanic personality was related to high suicidal ideation and the evening-type group was more hypomanic than the morning-type group. Selvi et al. (2011) reported that impulsivity is related to violent suicidal attempts. Generally, impulsivity is considered to be an important characteristic of hypomanic personality.

There are some limitations to the present study. First, we did not analyze the causal relationships between biological rhythm and suicidality. There may exist other moderators in this relationship. Further studies should examine these questions in a larger cohort. Second, suicidal idea does not completely/entirely reflect suicidal attempt. Suicidal attempter should be recruited and analyzed in terms of biological rhythm in a future study. Lastly, our SAD group included summer, winter, and subsyndromal SAD. There may be pathophysiological differences related to suicidal ideation or other clinical symptoms among them.

Despite these limitations, the current study is the first to compare suicidality in patients with MDD according to biological rhythm such as seasonality and chronotype. We found that suicidality is greater in SAD patients relative to non-SAD patients. Also, MDD patients with evening-type showed greater suicidality compared to morning-type patients. Our results suggest that biological rhythm is closely related to suicidality in patients with MDD. Thus, it would be recommendable for clinicians to screen the patients about their seasonality and chronotype in order to recognize and prevent the risk of suicide. Further studies are needed for biological alteration and melatonin level changes associated with those issues.

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Conflict of interest

No conflict declared.

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