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Effects of phantom shocks on anxiety levels, coping skills and sleep quality in patients with implantable cardioverter/defibrillators

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ABSTRACT

Aims: This study aimed to investigate the effects of phantom shocks on anxiety levels, coping skills, and sleep quality in patients with implantable cardioverter defibrillators (ICDs). Specifically, it examined the relationship between phantom shocks and these psychological variables by comparing ICD recipients who had experienced phantom shocks with those who had not.

Methods: This observational study included 66 patients with ICDs, divided into two groups: those who had experienced phantom shocks (PS+) and those who had not (PS-). An additional control group of 66 participants without heart failure or ICD implantation was also included. Participants completed the Beck Depression Inventory, the State-Trait Anxiety Inventory, Pittsburgh Sleep Quality Index, and Florida Shock Anxiety Scale. Data were analyzed using SPSS software to compare psychological outcomes across the groups.

Results: Patients in the PS+ group demonstrated significantly poorer sleep quality, higher levels of general anxiety, and greater ICD-related anxiety compared to the PS- group. Furthermore, the PS+ group had a significantly higher prevalence of prior psychiatric diagnoses, including anxiety and depression, compared to both the PS- and control groups. The control group reported the best sleep quality and the lowest anxiety levels overall.

Conclusion: Phantom shocks are associated with impaired sleep quality, elevated anxiety, and increased ICD-related distress in patients with ICDs. These findings underscore the psychological burden faced by ICD recipients, particularly those experiencing phantom shocks. A multidisciplinary approach addressing both physical and psychological aspects is crucial for enhancing the overall well-being of these patients.

Keywords: Phantom shocks, ICD, anxiety, sleep quality, psychological distress

INTRODUCTION

An implantable cardioverter defibrillator (ICD) is an internal electronic device designed to detect and correct life-threatening arrhythmias. When used in conjunction with cardiac resynchronization therapy defibrillators for patients with heart failure, ICDs are shown to significantly reduce the risk of sudden cardiac death compared to anti-arrhythmic drug treatments. However, some ICD patients experience psychological distress due to concerns about receiving electric shocks or intense pain. A recent systematic review revealed that 5-41% of patients with ICDs reported depressive symptoms, while 8-63% reported experiencing anxiety. Depressive symptoms, in particular, are a significant psychological challenge for these patients, with studies indicating that 11-28% of them suffer from major depressive disorder, often with severe progression. Furthermore, depressive symptoms have been associated with a range of negative outcomes, such as poor medication adherence, arrhythmic events, phantom shocks, rehospitalization, and increased mortality. Some earlier research suggested that younger age, being female, lacking social support (e.g., living alone), having poor physical health (such as heart failure), and experiencing electric shock events may increase the likelihood of developing depressive symptoms. Despite these findings, the precise personal factors contributing to depressive symptoms remain insufficiently defined, although anxiety-related factors have been more clearly identified.[1,2]

Sleep disturbances have been a topic of research in ICD recipients, with varying reports from patients who have received these devices. In a study involving a mixed group of 105 pacemaker and ICD recipients, 44% of participants reported poor sleep quality. Quality of life (QoL) is often defined in part by symptoms like sleep issues and disturbances. One study examining QoL in patients with life-threatening arrhythmias found that ICD recipients experienced more sleep disturbances compared to a control group of cardiac patients.[3,4] Despite advancements in ICD technology, complications continue to occur frequently. One of the lesser-known complications is phantom shock, first described by Kowey et al.[5] in 1992. They reported a patient who experienced

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the sensation of a shock without an actual discharge from the ICD. The incidence of phantom shocks in ICD recipients is still not well understood, and the risk factors associated with its occurrence remain unclear.[6] Research indicates that psychological factors may play a crucial role in the occurrence of phantom shocks.[7] A study by Prudente et al.[8] found that patients experiencing phantom shocks exhibited higher levels of anxiety and depression compared to those without such experiences. Specifically, the phantom shock group had significantly greater depression (p=0.011) and anxiety (p=0.010) scores. These findings suggest that mental health conditions could contribute to the manifestation of phantom shocks, highlighting the importance of comprehensive psychological assessment and support for ICD recipients. In our study, we sought to determine the relationship between phantom shocks and ICD-receiver patients' well-being, life quality and depression and anxiety measures.

METHODS

Ethics

This study was conducted in accordance with the principles of the Declaration of Helsinki. All participants were expected to give signed informed consent. The study was carried out with the permission of the Samsun University Clinical Researches Ethics Committee (Date: 12.07.2023, Decision No: 2023/13/16).

Patient Enrollment

Patients who applied to Samsun Training and Research Hospital Cardiology Polyclinic between June and November 2023 for routine ICD interrogation were evaluated by a psychiatrist after device interrogation was made and received scales/inventories that we will mention in following parts of this manuscript. After that patients were grouped into two; individuals who experienced phantom shocks (group PS+) and those who did not (group PS-). The control group consisted of patients among the population admitted to Samsun Training and Research Hospital Psychiatry Polyclinic for routine health examinations for different causes, job applications, university registrations without prior diagnosis for heart failure and without history of ICD implantation or aborted sudden cardiac death.

Criteria for Excluding Participants from the Research

Presence of a neurological disease that may cause serious disability (epilepsy, cerebrovascular disease), being under psychotropic drug treatment, mental retardation, psychotic disorder, being diagnosed with a bipolar disorder, being in pregnancy and breastfeeding, autism spectrum disorder, presence of organic brain damage, smoking, alcohol and substance use disorder were determined as exclusion criteria. Additionally, patients whose left ventricle ejection fraction was ≥35, who experienced an acute stressful life event or surgery or hospitalization due to acute illness in last six months, whose functionality was New York Heart Association (NYHA) class IV, who were younger than 18 or older than 70 years also excluded from enrollment.

The power analysis was conducted using the G*power v3.1.9.6 program. With a confidence level of 95% (1-α), a test power of 98% (1-β), and an effect size (f) of 0.8, the minimum number of patients to be included in the study is determined to be 20 in each group, totaling 60 patients. After the evaluation, consecutive twenty-two patients were enrolled in each group (66 patients in total). Age-sex matched control group patients were enrolled from a group of volunteers who were admitted to the hospital for routine health examinations for different causes, job applications, university registrations, and so on. The same exclusion criteria were applied to this group, and volunteers who were presumed to have created significant differences between the control and patient groups in terms of marital status, education degree, and economic level were excluded.

Data Collection Tools

Sociodemographic information form: The sociodemographic information form prepared by the researcher contains items that will be used to determine the personal information of the participants and some other specified variables. Participants were asked not to give their names and to use pseudonyms.

Structured clinical study form for DSM-V Axis 1 disorders (SCID-1): SCID-1 is a semi-structured clinical interview scale developed to make basic axis 1 diagnoses.[9] Turkish adaptation and reliability studies were carried out by Elbir and colleagues.[10]

Beck Depression Inventory: Depressive symptoms were assessed using the Beck Depression Inventory, Version II (BDI-II), a widely recognized tool developed by Beck, Steer, and Brown in 1996, and later validated by Kojima et al.[11] in 2002. The BDI-II focuses on evaluating the severity of depressive symptoms, rather than diagnosing a clinical depressive episode. It consists of 21 self-reported items, with responses rated on a four-point Likert Scale, ranging from 0 to 3. The total score ranges from 0 to 63, with the following classifications: 0-13 indicating minimal depressive symptoms, 14-19 mild, 20-28 moderate, and 29-63 severe. A score above 14 is considered indicative of depressive symptoms. The reliability and validity of the BDI-II have been well-established in prior research, with Cronbach's alpha ranging between 0.92 and 0.93, confirming its strong internal consistency.

State-Trait Anxiety Inventory: The "state" component of the State-Trait Anxiety Inventory (STAI) includes 20 statements, with participants rating how they feel about each on a 4-point scale. Higher scores indicate higher levels of anxiety. This scale is highly sensitive to variations in transient anxiety and has been extensively used in research involving cardiovascular and ICD patients. The internal consistency of the scale, as measured by Cronbach's alpha, is 0.95, demonstrating exceptional reliability.[12]

The Pittsburgh Sleep Quality Index: The Pittsburgh Sleep Quality Index (PSQI) measures sleep quality using 19 self-rated questions that assess sleep patterns over the past month, such as "How often have you had trouble sleeping due to waking up in the middle of the night or early morning?" There are also five questions rated by a bed partner or roommate for clinical use. The 19 items are divided into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction due to sleepiness, all rated on a 0-3 scale. These component scores are combined to produce a global PSQI score, which ranges from 0 to 21. Higher scores indicate worse sleep quality, with a score above 5 signaling poor sleep. The PSQI, based on clinical experience rather than factor analysis, has been shown to have strong internal consistency (Cronbach's alpha=0.83) and is effective in distinguishing between sleep-disordered patients and controls. In this study, Cronbach's alpha was 0.85, supporting its reliability.[13,14]

Florida Shock Anxiety Scale: The Florida Shock Anxiety Scale (FSAS) is a tool designed to assess anxiety related to the experience of receiving a shock from an implantable cardioverter defibrillator (ICD). The scale consists of 10 questions, each rated on a 5-point Likert Scale, ranging from 1 (never) to 5 (always). The questions focus on aspects such as fear of receiving a shock or distress associated with the anticipation of shock events. Higher scores on the scale indicate greater levels of anxiety. The FSAS is designed to measure both cognitive anxiety (concerns and fears about shocks) and emotional anxiety (distress related to shock events). The total score is calculated by summing the individual responses, with higher scores indicating greater anxiety. A score of 20 or higher typically signals clinically significant anxiety. Previous studies have confirmed the scale's reliability, with Cronbach's alpha reported as 0.91, indicating strong internal consistency in evaluating shock-related anxiety in ICD patients.[15]

Data availability Statement

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Statistical Analysis

All data analyses were performed using the IBM SPSS Statistics for Windows (version 21.0; IBM Corp., Armonk, NY, USA). The distribution of continuous variables was tested using the Kolmogorov-Smirnov test. Accordingly, T test or Mann-Whitney U tests were used to compare the continuous variables according to the distribution of the data. Chi-square or Fisher's exact test was used to compare categorical variables. Continuous variables were presented as mean±SD whereas categorical variables were presented as counts and percentages.

RESULTS

The sociodemographic characteristics of three groups [PS (+), PS (-) and control] were similar in terms of mean age, marital status, economic income, employment status, and degree of literacy (**Table 1**). Comorbidity like diabetes, hypertension,

Table 1. Sociodemographic characteristics of participants

Parameter	Phantom shock (+) group (n=22)	Phantom shock (-) group (n=22)	Control group (n=22)	p-value
Age, years	59.4±6.5	60.9±6.1	60.7±4.7	0.636
Male gender (n, %)	11 (48%)	12 (58%)	11 (48%)	0.442
Working status				
Employed (n, %)	10 (46%)	12 (58%)	11 (48%)	0.437
Marital status				
Single/divorced (n, %)	8 (36%)	4 (18%)	6 (28%)	0.074
Educational degree				
Middle school (n, %)	7 (31%)	8 (36%)	7 (31%)	
High school (n, %)	7 (31%)	6 (28%)	7 (31%)	0.950
University or higher (n, %)	8 (36%)	8 (36%)	8 (48%)	
Financial status				
Low income (n, %)	3 (14%)	4 (18%)	3 (14%)	
Middle income (n, %)	14 (64%)	6 (28%)	14 (64%)	0.266
High income (n, %)	5 (22%)	12 (54%)	5 (22%)	
Previous psychiatric diagnosis				
Anxiety disorder (n, %)	7 (30%)	1 (4%)	3 (14%)	<0.001
Depression (n, %)	12 (52%)	8 (34%)	10 (42%)	
Cardiovascular risk factors				
Diabetes (n, %)	6 (27%)	8 (34%)	7 (30%)	0.811
Smoking (n, %)	8 (34%)	6 (27%)	8 (34%)	0.761
Hypertension (n, %)	8 (34%)	10 (45%)	8 (34%)	0.776
Mean ejection fraction (%)	28.6±5.1	28.1±5.1	55.8±4.7	0.01
Ischemic etiology (n, %)	6 (27%)	8 (34%)	8 (34%)	0.761
Physical capacity in NYHA class (n, %)				
I	4 (18%)	4 (20%)	14 (65%)	
II	12 (55%)	11 (50%)	8 (35%)	0.002
III	6 (27%)	7 (30%)	0	
Device-related characteristics				
Positive history for appropriate shock therapy (n, %)	6 (28%)	5 (22%)	n/a	0.728
Primary prophylactic implantation (n, %)	13 (60%)	17 (77%)	n/a	0.195

NYHA: New York Heart Association, p-value is significant for <0.05

ischemic heart disease and smoking status were comparable between three groups. However, PS (+) group and PS (-) group had similar degree of left ventricle failure depicted as low ejection fraction where as control groups' mean left ventricle ejection was in normal range as expected. Also, PS (+) and PS (-) groups were consisted of similar amounts of patients with functional class NYHA I and II and III. Control group naturally had better functionality because heart failure patients were excluded from this group. In terms of device-related characteristics, group PS (+) and group PS (-) were consisted of similar number of individuals who received appropriate ICD shocks. Device indication was mostly for primary prophylaxis in both groups.

All attendees underwent BDI-II, PSQI, FSAS and STAI-S evaluation. In Table 2, all three groups' results were depicted. Group PS (+) had worst among three groups, group PS (-) had worse than control groups' results in all tests. Furthermore, in terms of psychiatric disease history, group PS (+) had significantly more patients who had history for anxiety and depression. Phantom shock experience and previous depression and/or anxiety background may have a mutual effect on worse results of sleep quality and ICD shock expectations.

DISCUSSION

Our findings indicate that patients with ICD who have experienced phantom shocks reported significantly poorer sleep quality, higher levels of general anxiety, and greater ICD-related anxiety compared to those who had not experienced phantom shocks. To the best of our knowledge, this is the first study to employ both the Pittsburgh Sleep Quality Index and the Florida Shock Anxiety Scale in the evaluation of ICD recipients, utilizing a comparative approach involving two study groups and one control group.

Heart failure is a clinical syndrome characterized by the heart's inability to pump blood effectively, leading to symptoms such as fatigue, dyspnea, and fluid retention. The management of heart failure involves a multifaceted approach, including guideline-directed medical therapy, which aims to alleviate symptoms, prevent disease progression, and reduce mortality. Guideline-directed medical therapy typically encompasses the use of angiotensin receptor-neprilysin inhibitors, beta-blockers, mineralocorticoid receptor antagonists, and sodium-glucose cotransporter-2 inhibitors.[16]

For patients with HF at high risk of sudden cardiac death, the implantation of an ICD is recommended. ICDs are designed to detect and terminate life-threatening arrhythmias through electrical shocks, thereby improving survival rates. However, while ICDs provide clear survival benefits, their implantation and the possibility of receiving shocks can have unintended psychological effects. Studies have demonstrated that ICD recipients often experience increased anxiety, with prevalence rates ranging from 24% to 87%. This heightened anxiety is associated with concerns about device function and the potential for unexpected shocks.[17]

Furthermore, the presence of an ICD has been linked to sleep disturbances among patients. The anticipation of potential shocks and the psychological burden of living with an ICD can contribute to insomnia and other sleep disorders. These sleep disturbances, in turn, can negatively impact overall well-being, leading to diminished quality of life. The interplay between device-related anxiety and sleep quality underscores the importance of comprehensive care that addresses both the physical and psychological needs of HF patients with ICDs.

Phantom shocks, also referred to as "perceived" or "false" shocks, are sensations experienced by patients with ICDs in which they feel a shock but no actual discharge occurs. These perceived shocks can occur in the absence of any arrhythmic event that would typically trigger an ICD discharge. Phantom shocks are distinguished from appropriate shocks, which are real electrical discharges delivered by the ICD to terminate life-threatening arrhythmias such as ventricular tachycardia or ventricular fibrillation. The ICD is designed to detect these arrhythmias through continuous monitoring of the heart's rhythm, and upon identifying a life-threatening irregularity, it administers a shock to restore normal cardiac rhythm. While appropriate shocks serve as life-saving interventions, phantom shocks are non-therapeutic and do not correspond to any abnormal arrhythmic event.

The mechanism of appropriate shocks is based on the ICD's ability to detect certain arrhythmias and respond with therapeutic electrical impulses. When the ICD senses arrhythmias that meet specific parameters-such as ventricular tachycardia or ventricular fibrillation-it delivers electrical therapy to the heart in the form of a shock. This shock is intended to stop the abnormal rhythm and allow the heart to revert to a normal sinus rhythm. The appropriate shock mechanisms have been well-documented in numerous studies, which highlight the life-saving potential of ICDs in preventing sudden cardiac death in patients at high risk for arrhythmias. The device continuously monitors the heart's electrical activity, ensuring that it only delivers shocks when necessary. Although the shock is often uncomfortable, it is a critical intervention that significantly reduces the risk of fatal arrhythmias. In contrast, phantom shocks are characterized by the sensation of a shock, despite the absence of any electrical discharge from the ICD. The underlying causes of phantom shocks are not yet fully understood, but several mechanisms have been proposed based on clinical observation and research. One of the most prominent factors associated with phantom shocks is heightened anxiety. Patients with ICDs often experience significant psychological distress, including anxiety about the possibility of receiving shocks, which may contribute to the perception of phantom shocks. Anxiety has

Table 2. Comparison of scale and inventory scores of all groups

Test type	PS (+) group mean score (n=22)	PS (-) group mean score (n=22)	Control group mean score (n=22)	PS (+) vs PS (-)	PS (+) vs control	PS (-) vs control
BDI-II	41.5±9.5	34.7±6.9	17.2±5.3	0.01	<0.01	<0.01
STAI-S	41.1±4.6	34.9±6.1	15.6±6.4	<0.01	<0.01	<0.01
PSQI	13.3±3.4	10.8±4.1	4.0±1.9	0.033	<0.01	<0.01
FSAS	31.8±8.4	23.5±8.8	n/a	0,003	n/a	n/a

BDI-II: Beck Depressive Inventory II, STAI-S: State-Trait Anxiety Inventory-State, PSQI: Pittsburgh Sleep Quality Index, FSAS: Florida Shock Anxiety Scale, N/a: Not applicable, PS (+): Group of patients with positive history for phantom shock, PS (-): Group of patients with positive history for phantom shock, p value is significant for <0.05

been shown to exacerbate the perception of bodily sensations, and patients who are anxious about their ICD may be more likely to misinterpret normal sensations (e.g., muscle spasms or palpitations) as shock-related. Research has demonstrated a strong association between anxiety and phantom shocks, suggesting that heightened emotional distress may lead patients to become hypervigilant to bodily sensations, which could in turn contribute to the sensation of a shock when none is actually delivered. A study by Kowey et al.[5] emphasized the psychological impact of ICD implantation and identified anxiety as a significant factor in the perception of phantom shocks. Anxiety-related hypervigilance may cause individuals to experience sensations akin to the shock, even when the ICD has not activated. Furthermore, patients who experience phantom shocks are more likely to report higher levels of anxiety, suggesting a bidirectional relationship between anxiety and phantom shocks.[18]

Another theory suggests that phantom shocks may be related to post-traumatic stress, specifically in patients who have had prior ICD shocks. Patients who have experienced an actual shock may develop post-traumatic stress responses, where the traumatic memory of receiving a shock is reactivated. This memory could lead to the perception of phantom shocks, even in the absence of actual arrhythmic events. The traumatic experience of receiving an ICD shock could create a lasting psychological imprint that triggers the sensation of a shock under certain conditions. Research supports this theory, as patients with a history of ICD shocks are more likely to report phantom shocks. The reactivation of traumatic memories related to the shock experience may contribute to the heightened perception of phantom shocks, and psychological therapies aimed at addressing post-traumatic stress may help reduce the frequency of these events.[19]

Another possible explanation for phantom shocks is sensory misinterpretation, which occurs when normal bodily sensations, such as muscle twitches, heart palpitations, or changes in posture, are mistakenly interpreted as shocks. This phenomenon is thought to arise from the patient's heightened awareness and sensitivity to any physical sensations, due to the presence of the ICD. This hypervigilance can lead to an increased likelihood of misperceiving benign sensations as the result of an ICD discharge. The presence of the ICD itself can create a constant focus on potential shocks, leading patients to be more attuned to bodily sensations that might otherwise be unnoticed. Sensory misinterpretation is thought to be a common occurrence among individuals with medical devices, and it is further exacerbated by anxiety and stress, which heighten the sensitivity to any physical stimuli.[20]

Although less frequently cited, some have suggested that certain device-related factors, such as lead positioning or sensitivity settings, may contribute to the perception of phantom shocks. If the ICD leads are positioned in such a way that they trigger minor electrical discharges or cause sensations similar to a shock, patients may perceive these as phantom shocks. However, current evidence does not strongly support this hypothesis, and phantom shocks are more often associated with psychological and sensory factors rather than technical device malfunction.

The relationship between phantom shocks and psychological distress, particularly anxiety, is crucial in understanding their impact on patient well-being. Anxiety is a common emotional response in patients with ICDs, as they worry about receiving shocks, which can lead to heightened vigilance and even anticipatory anxiety about the possibility of future arrhythmic events. As mentioned earlier, patients with anxiety disorders are more likely to experience phantom shocks, and these false perceptions can further exacerbate feelings of distress. Phantom shocks not only contribute to emotional and psychological distress but also negatively affect patients' overall quality of life and sleep quality. The anxiety associated with the anticipation of shocks, as well as the distress caused by phantom shocks, can significantly impair daily functioning, contributing to diminished well-being and quality of life.

ICD recipients often face significant psychological challenges, with some individuals exhibiting a diminished capacity to cope with the stress associated with their device. This impaired coping ability can manifest as heightened anxiety and depression, potentially exacerbating their overall psychological distress. Notably, patients with lower self-efficacy-confidence in their ability to manage life situations-have reported increased fears related to ICD malfunction, limitations in daily activities, and a greater prevalence of physical symptoms. These factors collectively contribute to a compromised quality of life and may hinder effective adjustment to living with an ICD.[21] Conversely, the development and implementation of successful coping strategies can have a positive impact on the psychological well-being of ICD recipients, particularly concerning the phenomenon of phantom shocks-the sensation of receiving an ICD shock without actual device activation. While the exact mechanisms underlying phantom shocks remain unclear, evidence suggests that psychological factors, such as anxiety and depression, may play a role in their occurrence.[22] Interventions aimed at enhancing coping mechanisms, including patient education, mindfulness training, and the development of anxiety-relieving techniques, have been proposed to mitigate the incidence of phantom shocks. Furthermore, screening for and addressing underlying psychological conditions before device implantation may offer additional benefits in preventing phantom shocks and improving overall patient outcomes. [7,23]

Limitations

This study bears several noteworthy limitations that warrant consideration. First, the relatively low number of patients enrolled constrains the generalizability of the findings, limiting the extent to which the results can be extrapolated to the broader ICD recipient population. A small sample size may also hinder the statistical power needed to detect subtle psychological or psychosomatic phenomena such as phantom shocks. Second, the study did not utilize standardized psychometric tools specifically designed to assess coping ability. This absence restricts the capacity to draw robust conclusions about the relationship between coping mechanisms and the psychological outcomes observed. Additionally, the lack of longitudinal follow-up data impairs the ability to monitor evolving psychological responses over time, especially in relation to ICD-related distress and adaptation. Finally, the study did not control for certain confounding variables such as pre-existing psychiatric diagnoses, medication use (e.g., antidepressants or anxiolytics), and the presence of social support systems, all of which may significantly influence both the perception of phantom shocks and the efficacy of psychological coping.

CONCLUSION

Phantom shocks are a complex and distressing phenomenon for many ICD recipients. While their exact cause is not fully understood, it is clear that psychological factors, such as anxiety, play a significant role in their occurrence. Addressing these psychological factors, particularly through anxiety management and psychological support, may help alleviate the occurrence of phantom shocks and improve the overall quality of life for ICD patients. Furthermore, a comprehensive treatment approach that includes both physical and psychological support is essential in managing the well-being of ICD recipients.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Samsun University Clinical Researches Ethics Committee (Date: 12.07.2023, Decision No: 2023/13/16).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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