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Massively Multiplayer Online Role-Playing Game-Induced Seizures: A Neglected Health Problem in Internet Addiction

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ABSTRACT

As the Internet has become rapidly and widely integrated into society, Internet addiction has become a growing psychosocial problem. However, epileptic seizure, another out-of-the-ordinary health problem, is often neglected in this regard. Ten patients who experienced epileptic seizures while playing the newest genre of electronic games—Massively Multiplayer Online Role-Playing Games (MMORPGs)—were investigated. Patients were predominantly male young adults, and most of the events were generalized tonic-clonic seizures, myoclonic seizures, and absences. These patients should be categorized into idiopathic generalized epilepsies. Even though photosensitivity was an important factor, behavioral and higher mental activities also seemed to be significant seizure precipitants. Results demonstrated that MMORPG-induced seizures were not analogous to the ordinary video game–induced seizures. Significantly, an epileptic seizure warning did not always appear on the websites of MMORPGs and instructions for the software. While the prevalence of MMORPG-induced seizures remains unknown, it may exceed our expectations and impact our society. Not only for clinical neurologists but also for the primary physicians, educators, sociologists, and global online game publishers, there should be an awareness of this special form of reflex seizures in order to provide an appropriate health warning to MMORPG players.

INTRODUCTION

RECENT ADVANCES in Internet technology have ushered "gaming" into a new era. Many players are now able to connect to each other through the Internet and play online games together. Currently, the fastest-growing forms of electronic games—Massively Multiplayer Online Role-Playing Games (MMORPGs)—are available worldwide and are often inhabited by thousand of players on a daily basis.[1] They are different from ordinary video games; in fact, they are not really games at all. These MMORPGs create a self-contained three-dimensional virtual world where the player is represented as a versatile avatar who can walk, talk, and do just about anything the game developers want them to. MMORPG dwellers may be involved in hunting or combat, and they may also fall in love, make friends, and form communities, which offer a sense of belonging and encourage them to take part in various economic activities.[2]

A famous online game, "Lineage," that was developed by NCsoft (Seoul, South Korea) is the most popular MMORPG in Taiwan and Korea.[2] As of September 2004, the number of active subscribers was estimated to exceed 860,000 in Taiwan, with the highest number of concurrent players estimated to be over 200,000.[3] Considering all the other MMORPGs that exist globally, the number of online game participants is estimated to exceed 3.4

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million in Taiwan, 4 million in Korea, 2 million in the United States, and 7.7 million in China.[3] Undoubtedly, MMORPGs have been become a preferred leisure activity for adolescents and young adults, in which players are living in a virtual space and represent a characterized lifestyle in MMORPG realms.[2]

Online games are now so pervasive that they are perceived as a public health threat in some quarters.[1] The newer genre of online games is more graphic, more complex, more bloodthirsty, and more violent than earlier computerized games. There are studies that delved into game-related psychological impact, emotional disturbance, obsessive thoughts and violence.[2,4–6] The aspects of online game-related physical health problems, however, such as epileptic seizures, are infrequently measured.

Activation of epileptic seizures by game playing has long been delineated. Since the late 1950s,[7] Bingel reported a patient that developed seizure while playing cards. Furthermore, in 1981, Rushton[8] described the first case of epileptic seizures induced by a video game. Since then, there were numerous cases reported in literature in which epileptic seizures were thought to have been associated with playing computerized or non-computerized games. These games have included card games, Mah-Jong, chess, draughts, checkers, and computerized games.[9–13] Although game-related epilepsy is not a new syndrome, the nature of the link between the various games and epileptic seizures is uncertain. Studies of video game–induced seizures always concluded video game-induced epilepsy was a homogenous syndrome with an easily demonstrable photosensitivity on intermittent photic stimulation.[12,14,15] However, the cases of epileptic seizures associated with MMORPGs have not been reported in the literature.

In this study, 10 patients who had seizures while playing MMORPGs were studied. The study aimed to ascertain whether MMORPG-induced seizures are analogous to video game-induced seizures, and to elucidate the possibility of relations with idiopathic generalized epilepsies (IGE) and the probable mechanisms of seizure precipitation. Perhaps, there should be cause for alarm for the educators and online game publishers.

METHODS

Between January 2000 and December 2004, 10 patients who had experienced epileptic seizures while playing MMORPG were evaluated at the Epilepsy Outpatient Clinic of the Chang Gung Memorial Hospital-Kaohsiung, Taiwan. Length of follow-up was 6–24 months. Clinical information obtained retrospectively from clinical records and interviews included the age at onset, gender, personal and family history, the specific game of seizure activation, clinical pattern and frequency of seizures associated with or without the MMORPGs, and antiepileptic drug therapy and clinical outcome.

Other specific games included chess, card games, board games, video or television (TV) games, newly specialized game consoles (e.g., Xbox, Microsoft, and PlayStation, Sony Computer Entertainment Inc.), and personal computer (PC) games. Whether these games served as seizure inducers in the MMORPG-responsive patients was evaluated.

All of the patients underwent physical and neurologic examinations, electroencephalogram (EEG) studies, and brain magnetic resonance imaging (MRI) studies. Intelligence was assessed by the Wechsler Adult Intelligence Scale. EEG recordings were carried out in 12- or 16-channel machines taken during wakefulness and sleepiness, hyperventilation, and stroboscopic stimulation at rates of 1–24 Hz, but not during the actual playing of the online games. The seizure types and epileptic syndromes were categorized according to the International League Against Epilepsy (ILAE) classification of epilepsies and epileptic syndromes.[16]

RESULTS

Results of basic clinical data, seizure semiology, laboratory findings, and therapy for the 10 patients are summarized in Tables 1 and 2.

The age at onset of first online game–induced seizure was 14–30 years, with a mean age of 19.8 years. Eight patients (patients 1 and 4–10) had a history of epileptic seizures before the first attack of online game-induced seizure. The onset of epilepsy was 11–19 years, with a mean age of 14.5 years. Among these 10 patients, there were eight males (80%) and two females (20%). This condition appeared to have a predominance of males.

Aside from playing MMORPGs, six patients had seizures while playing other forms of game, including video/TV games, a special game console, PC games, Chinese chess, and card games. There was no family history of epilepsy in any of the patients. Previous medical histories were unremarkable except for patient 1, who had a history of febrile convulsion. Seizure latency after playing an online game was highly variable, ranging from 1 to 12 h.

TABLE 1. BASIC DATA AND SEIZURE SEMIOLOGY IN 10 PATIENTS WITH MMORPG-INDUCED SEIZURES

Patients	*Sex*	*Age at onset*[a]	*Onset of epilepsy*[b]	*Clinical seizure patterns*	*Associated epileptic syndrome*	*Other games of seizure activation*
1	F	19	16	GTCS	GTCS alone	No
2	M	14	14	GTCS	GTCS alone	No
3	M	18	18	GTCS	GTCS alone	Video/TV game, PC game, game console
4	M	25	11	GTCS	GTCS alone	Card game
5	F	23	15	GTCS	GTCS alone	No
6	M	15	14	MS, GTCS	JME	PC game
7	M	16	13	MS, GTCS	JME	No
8	M	23	12	MS, GTCS	JME	Chinese chess
9	M	30	19	MS, GTCS	JME	Video/TV game, PC game
10	M	15	13	ABS, MS, GTCS	JAE	Video/TV game, PC game, game console

[a]The age at onset of first online game epilepsy (years).
[b]The age at onset of epilepsy (years).
M, male; F, female; GTCS, generalized tonic-clonic seizure; MS, myoclonic seizure; ABS, absence; JME, juvenile myoclonic epilepsy; JAE, juvenile absence epilepsy; PC, personal computer; TV, television.

Whereas different subjects have different favorite games, four patients (patients 1, 2, 5, and 7) who manifested MMORPG-induced seizures were not found to be responsive to the other games.

Physical and neurological examinations were normal in all of the patients.font-family:NewCenturySchlbk-Roman; All had average or above average intelligence and brain MRI studies revealed negative results. Interictal EEG studies showed normal background activity without epileptiform discharges in 3 patients. One patient (patient 4) had slow back ground activity intermingled with a small amount of theta activity. Epileptiform discharges were found on the EEGs in six patients (60%), with five showing typical generalized spike-and-wave or polyspike-and-wave discharges. There was no photosensitivity to intermittent photic stimulation in any patient.

TABLE 2. LABORATORY FINDINGS AND TREATMENT IN 10 PATIENTS WITH MMORPG-INDUCED SEIZURES

Patients	*Interictal EEG finding*	*Brain MRI*	*Therapy*	*Outcome*
1	Normal	Negative	VPA	Seizure-free for 10 months
2	Normal	Negative	CBZ	Ineffective
			VPA	Seizure-free for 9 months
3	Intermittent bilateral frontal sharp waves	Negative	VPA	Controlled
4	Slightly slow background	Negative	VPA	Controlled
5	Normal	Negative	PHT	Controlled
6	Polyspike-and-waves	Negative	VPA	Seizure-free for 14 months
7	Polyspike-and-waves	Negative	VPA	Seizure-free for 13 months
8	Polyspike-and-waves	Negative	VPA	Seizure-free for 24 months
9	Polyspike-and-waves	Negative	VPA	Seizure-free for 16 months
10	Generalized spike-and-waves	Negative	GBP	Aggravated
			VPA + CNP	Seizure-free for 6 months

EEG, electroencephalogram; MRI, magnetic resonance imaging; VPA, valproic acid; PHT, phenytoin; CBZ, carbamazepine; GBP, gabapentin; CNP, clonazepam.

All of the patients experienced generalized tonic-clonic seizures. Five patients (patients 6–10) experienced a coexistence of myoclonic seizures and/or absences with generalized tonic-clonic seizures. Based on the seizure semiology and EEG findings, they were classified into IGE by the ILAE classification of epilepsies and epileptic syndromes.[16] The clinically recognizable subtypes included other IGE with generalized tonic-clonic seizures alone in five patients (patients 1–5), juvenile myoclonic epilepsy (JME) in four (patients 6–9), and juvenile absence epilepsy (JAE) in one (patient 10).[17]

All patients regularly received antiepileptic drug therapy and consecutive follow-up. Carbamazepine was given alone to patients 2, but it was ineffective in controlling online game-induced and spontaneous seizures. Moreover, gabapentin monotherapy had been given to patient 10 but was ineffective and aggravated absences and myoclonic seizures. Except for patient 5 received phenytoin therapy, nine of the patients had been receiving valproic acid therapy. Valproic acid alone or combined with clonazepam showed effective control on all types of game-induced seizures and spontaneous seizures. Seven patients (patients 1, 2, and 6–10) were seizure-free during the follow-up period.

DISCUSSION

With the Internet rapidly and widely integrated into Taiwanese and Korean societies, Internet addiction is a growing psychosocial problem and has become an important issue for psychologist and educators.[2,5,6,18] Because Internet addiction is a relatively new concept, many studies have been conducted to evaluation its psychosocial effects on its users. However, there are few studies concerning medical health problems caused by Internet addiction, especially by playing the online games. This study describes the clinical features of 10 patients with epileptic seizures while playing MMORPGs, and thus provides an initial window to a health problem from over-use of the Internet.

The mean age at onset of MMORPG-induced seizures is significantly older than the reported age at onset of video game-induced seizures.[10,12] This result is consistent with the usual population of online game players, those aged between 15 and 29 years, in Taiwan. The events were primary generalized tonic-clonic seizures, myoclonic seizures, and absences. There might be coexistent myoclonic seizures and/or absences with generalized tonic-clonic seizures. Based on the seizure semiology, the patients were noted to have adolescent-onset IGE syndromes, including other IGE with generalized tonic-clonic seizures alone, JME, and JAE.[17] These findings suggest that MMORPG-induced seizures could overlap with adolescent-onset IGE syndromes. Two patients (patients 2 and 3) experienced first generalized tonic-clonic seizure while playing MMORPG before the diagnosis of epilepsy. It is very important, in patients with JME or JAE that epilepsy be diagnosed even when an online game-induced generalized tonic-clonic seizure supervened. Game-induced myoclonic seizures or absences were not ignored.

The pathophysiologic mechanisms underlying the reflex epilepsy induced by game playing has not yet been well established. According to previous studies on video game-induced seizures and TV-induced seizures, photosensitivity, pattern sensitivity, chromatic sensitivity and stimulus frequency were emphasized.[12,14,15,19] In this study, although all patients had seizures while playing MMORPGs, two patient also experienced seizure while playing card games or Chinese chess. No patient had a photoparoxysmal response to intermittent photic stimulation. Furthermore, a higher frequency of males was found in MMORPG-induced seizures, implying that a gender factor may play a role in this phenomenon. In the previous study on video-game induced seizures, this sex difference has been suggested that contributed to a greater number of male game players than female,[20] but a survey of online game playing in Taiwanese population found that male players accounted for 52% and female players accounted for 48% on October 2003.[21] Despite two-thirds of photosensitive patients being female,[22] the observation of male predominance further supported the assertion that factors other than photosensitivity may contribute to the pathophysiologic mechanism.

All of the patients had seizures in front of the computer monitor while playing games. Undeniably, clinical photosensitivity plays an important role in the generation of MMORPG-induced seizures in these patients, but it should not be the absolute single mechanism. Non-photic factors—such as anxiety, emotional excitement, stress, fatigue, diurnal variation in susceptibility, and cognitive processing—seemed to be important seizure precipitants. We propose that reflex mechanism involving higher mental stimuli during online game playing, which triggers generalized epileptogenicity, is another important mechanism of MMORPG-induced seizures. Probably, living with particularly complex lifestyles in the Internet-created virtual world, the perplexity of mixing reality and fantasy, and inconstant emotional disturbances will enhance the higher mental stimuli in MMORPG players. Thus, this form of re-

flex epilepsy induced by MMORPG playing is not analogous to photosensitive seizures in video game–induced seizures. In fact, higher mental activities can precipitate generalized spike-and-wave discharges, which may be accompanied by myoclonic seizures or absences that was suggested in relation to the IGE syndrome, including JME and JAE.[23,24]

Despite limited results from this study, the response to antiepileptic drug therapy was generally good. Aside from avoiding MMORPGs playing, antiepileptic drug therapy was necessary in these patients. Valproic acid alone or combined with clonazepam effectively controlled all types of online game–induced seizures and spontaneous seizures. Based on observations, carbamazepine and gabapentin were not suggested in patients with MMORPG-induced seizures.

Since MMORPG-induced seizures are also represented in the patients with adolescent IGE syndrome, an important issue should be highlighted. Parents, educators, and physicians must consider the risk in epileptic individuals who are overobsessed with an online game, as they may lose their medication in Internet cafés or forget to take their regular medications, consequently causing drug-withdrawal seizures. Furthermore, MMORPG addiction might change the players' circadian rhythm, life style and sleep hygiene that is also unfavorable for adolescent patients with epilepsy.

In conclusion, the results demonstrated that MMORPG-induced seizure is not a unique and homogenous syndrome, and is not analogous to video game-induced or TV-induced seizures. It may consist of distinct pathophysiologic mechanisms. However, the exact mechanism is not completely elucidated, and further studies are needed to confirm these observations. Of particular importance, warnings do not always appear on the websites of MMORPGs and on instructions for software. Even though the prevalence of MMORPG-induced seizures is still unknown, the number of global online game users has been estimated to exceed 18.3 million.[3] With the growing accessibility of the Internet and online games, clinical neurologists, educators, sociologists, and global online game publishers should all be aware of this special form of reflex seizures, which is not completely analogous to video game–induced seizures, in order to provide health warning information to MMORPG players.

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