Chapter 6

Reflex Epilepsy

Raidah Saleem AlBaradie

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/58462

1. Introduction

A reflex seizure is a condition in which seizures can be provoked habitually by an external stimulus or, less commonly, internal mental processes, or by activity of the patient. It is most commonly precipitated by visual stimuli. Other somatosensory occurrences, including thinking, reading, listening to music, and eating may also induce reflex seizures [1]. Reflex epilepsies are quite uncommon, occurring in only 5% of all epilepsies. Most of these epilepsies are genetic in origin [2].

The definition of reflex epilepsy was recognized initially by on International League Against Epilepsy classification in 1989 [3]. The classification in 2001 formed reflex seizure and epilepsy definitions. Three types of reflex seizure met clinically embrace pure reflex epilepsy, reflex seizures that happen in generalized or focal epilepsy syndromes that are also connected with spontaneous seizures, and isolated reflex seizures arising in conditions that do not essentially need a diagnosis of epilepsy.

Pathophysiology

The occurrence of seizures in people with epilepsy is rarely predictable. Elements that aggravate seizures may differ from person to person and may include sleep deprivation, systemic illness, or ingestion of particular food products [2]. These factors typically do not activate seizures in a consistent pattern and they may lower seizure threshold in patients with unprovoked seizures. In comparison, reflex seizures denote a time-dependent response to a particular stimulus.

An example of a trigger which more reliably causes interictal epileptic discharges (IEDs) or clinical seizures in photosensitive individuals is intermittent light stimulation (ILS). 12-to 18-Hz frequencies in photic stimulation are more likely to produce seizures than others, and the degree of photosensitivity may depend on the time of day, where it is increased early in the morning [4].

Reflex seizures are also provoked by the stimulation of other primary sensory cortices, such as the primary auditory, or somatosensory cortices, and by activation of premotor, pericingulate (SMA), and parietal lobe association cortices. It is proposed that the stimulus may create an abnormal response directly in the sensory or association cortices, with a synchronized discharge spreading functionally connected cortical or subcortical structures or a physiological reaction is in charge for the initiation of synchronization of larger networks or functionally connected epileptogenic cortex. In addition, forming of real connectivity during the photoparoxysmal response indicated the frontocentral cortices were already synchronized prior to the appearance of the ictal or interictal discharge [5].

Some studies showed diminished inhibition of the motor cortex during ILS which was seen by transcranial magnetic stimulation in photosensitive individuals. This decrease seems to denote synchronization of the frontocentral cortices or the absence of an inhibitory modulation by an intervening cortical region. In addition, it was noted in patients who were studied for resective surgery that a temporal lobe epileptogenic zone was activated by ILS without clear generation of the seizure from the occipital lobe. This support that there are mechanisms other than spread being crucial to induce "reflex seizures [6]. This was also supported by animal models studies, where it demonstrated an abnormal cortical development in the baboon in the histology and the morphology with reflex seizures [7].

Etiology

The cause of reflex epilepsy can be acquired or inherited. Reflex seizures rarely caused by acquired cerebral lesions. The most common etiologies which affect the brain frontal, temporal or parietal association cortices are strokes, encephalitis, or cortical dysplasia. In comparison to trauma and meningitis, which incline to affect more the anterior frontal and temporal lobes. The most common signs of acquired reflex epilepsy are startle seizures, which is presented clinically by sudden myoclonic or tonic contraction of the truncal and extremity musculature. This type of seizures can be triggered by somatosensory, auditory, or proprioceptive (movement) stimuli. It is correlated by a brief electroencephalographic discharge, which might be followed by a partial seizure. The perirolandic cortices and mesial frontoparietal networks are commonly implicated in the generation of reflex seizures [8].

Whereas the inherited reflex epilepsy is supported by animal models as stated earlier such as audio genic seizures characterize genetic reflex epilepsies in predisposed strains of mice, rats, and birds [9]. Recent studies demonstrated a link of photosensitivity to bands 7q32 and 16p13 by one group [10] and was linked to 6p21 and 13q31 by another [11]. Also, children with chromosomal abnormalities have been shown to have augmented affinity to photosensitivity. Hot water epilepsy (HWE) was linked to band 4q24-q28 in one family and to band 10q21-q22 in 6 families [12]. Patients with autosomal dominant temporal lobe epilepsy have seizures triggered by speech and auditory stimuli which is associated with mutations in the LGI1 gene in chromosome 10q22-q24 [13]. Several genetic factors predispose to reflex epilepsies, some related to channelopathies, other affecting brain development such as neurodegenerative disorders. They are stated to as progressive myoclonic epilepsies which includ Unverricht-Lundborg disease, Lafora disease, neuronal ceroid lipofuscinosis, and mitochondrial ence-

phalomyopathies (mitochondrial disorders complicated by cognitive decline and progressive weakness) [14].

Epidemiology

Females have more common photosensitivity but there is no sex predilection in reflex epilepsies [1].

2. Precipitating factors

2.1. Visual stimulus

Seizures can be provoked by visual stimulus such as flickering light, removal of visual fixation or light intensity, complex visual patterns, viewing particular objects, or other visual stimuli [15]. The most common type of visually induced seizure is photosensitive seizures. Photosensitivity is an abnormal visual sensitivity of the brain in response to flickering light sources. It is expressed in the electroencephalography (EEG) as a generalized spikes/polyspikes and wave discharge (photoparoxysmal response) produced by intermittent photic stimulation, or clinical seizures in vulnerable individuals [16]. The prevalence of photosensitivity in patients with epilepsy ranges from 2% to 20%. There are three groups of Photosensitivite subjects divided based on their response to (ILS) and it is more commonly associated with idiopathic generalized epilepsy, which constitutes 20-40% of all epilepsy:

1. Individuals who develop seizures only when they are exposed to light stimulus.
2. Individuals who experience seizures with or without light stimulus.
3. Asymptomatic individuals with a photosensitive reaction on EEG.

Photosensitivity is nearly twice as common in females as in males. 25% of patients lose their photosensitivity in their 20s and 30s. Genetic tendency play an important role in photosensitivity. Regional occipital cortical hyperexcitability is noted in functional magnetic resonance imaging (MRI) and magnetoencephalography in photosensitive patients [17]. It is proposed that there is hyperexcitability of the visual cortex in photosensitive patients as noted from human and animal data. When a sufficient large area from the visual cortex is stimulated, it will lead to an epileptiform discharge and a seizure might be provoked by mechanism requires the physiologic activation of a critical area of cortical tissue especially the parvocellar more than mangocellar pathway.The most common light source that plays a role in photosensitive seizures is television more than computer monitors and video games. The reflection of sunlight directly or intermittently on a road lined with trees, lamplights, and colorful and bright blinking lights are other stimuli in photosensitive subjects [17].

The treatment of photosensitive epilepsy can be achieved with or without combined antiepileptic drugs by avoiding the stimulus, stimulus modification such as avoidance of clear sources of blinking lights and video games, avoiding extended game play, increase distance from the television set, and using a remote control are all important and useful strategies. At times,

covering one eye and rotating if the screen flashes or if myoclonic jerks occur is useful. Use of 100 Hz television sets found to diminish sensitivity in many patients: the screen is naturally less provocative than a 50 Hz screen however screen content may still be stimulating. When needed, the drug of choice is valproate in monotherapy. Antiepileptic drugs that can be used in this condition such as clobazam, lamotrigine, topiramate, and levetiracetam might be helpful [18].

Photosensitive epilepsies usually carry very good prognosis, about 25% of patients with these conditions will lose their photosensitivity in their third decade. Most such patients will relapse if they discontinue the antiepileptic drugs early [19]. It worth to state that photosensitivity can be seen in idiopathic generalized epilepsies such as juvenile myoclonic epilepsy, and in crytogenic generalized epilepsies such as severe myoclonic epilepsy of infancy (Dravet syndrome), or with degenerative gray matter encephalopathies such as Lafora's disease, Unverricht-Lundborg disease, Kufs' disease, the neuronal ceroid lipofuscinoses, and in others progressive myoclonus epilepsies [19].

2.2. Somatosensory stimulus

It may include light touch, tapping, or immersion in hot water. The seizures can be provoked by touch may occur in infancy or childhood is called startle epilepsy or reflex myoclonic epilepsy [20]. The type of seizures inclines to be generalized and less commonly, partial-onset seizures which are activated by touch due to the activation of a sensorimotor cortex.

An important example of somatosensory stimulus induced seizure is hot water epilepsy (HWE) where seizures can be triggered by bathing with hot water pouring over the head, face, or neck. It was first described in 1945. It is the second most common type of reflex epilepsy after photosensitive epilepsy and it is considered to be rare. The seizure is induced when the individual is exposed to water warmer than 37 °C. HWE constitute 3.6-6.9% of all epilepsy cases. HWE occur mostly in infants and children and a male/female ratio of 2-3/1. But also it can be seen after 40 years of age. Familial HWE cases with more than one affected member have been reported in 7-15% of Indian patients, and 1-27% of these patients reported a history of febrile convulsions [21].

One of the important causes of HWE is the genetic etiology. Genome-wide linkage analysis of Indian families delivered proof of linkage for the disorder at 10q21.3-q22.3 and recognized a 15 Mb disease-associated haplotype in four out of six families analyzed [21]. It was noted in a study proven hyperthermic kindling in rats after several episodes of hot water stimulations, there was progressive epileptic activity displayed during lowering of rectal temperature thresholds from 41.5 to 40.0 ºC, drop in latency for developing seizures from 185 to 118 sec and increase in duration of hippocampal seizure discharge from 15 to 140 sec with gradual increase in difficulty of EEG after discharges and neuronal sprouting observed in supragranular molecular layer and in stratum lacunosum [22].

The EEG is usually normal interictally and in 15-20% might reveal diffuse abnormalities such as lateralized or localized spike discharges in the anterior temporal regions. There are technical limitations and difficulties in obtaining an ictal EEG records but a temporal lobe onset was

seen in few seizures. A normal computed tomography and MRI of the brain are seen in patients with HWE but in few reported cases a focal malformation of the left parietal cortex was detected with brain MRI. The underlying mechanism of HWE remains uncertain. It was suggested that repeated pouring of water (a kindling effect) and the temperature of the water (a facilitative or triggering factor) during bathing in genetically or anatomically vulnerable persons play a role in the pathophysiology and this starting stimulus is considered to be complex. It may include a mixture of factors, such as contact of scalp with hot water, the temperature of the water, and the specific cortical area of stimulation [23].

The management of HWE is to decrease the temperature of the water and altering the method of bathing. These may be enough to control the seizures. Adding an antiepileptic drug can be considered if the mentioned precautions fail. The used antiepileptic drugs include carbamazepine, phenytoin, phenobarbital, sodium valproate, oxcarbazepine, lamotrigine, clobazam, or levetiracetam. A self-abort the attack by distracting maneuvers, like listening to music, chanting the name of God, or remembering their dear ones might be used [24]. HWE usually carry good prognosis.

2.3. Auditory stimulation

Audiogenic seizures have been noted in many animal types and happen usually in employed mouse and rodent models of genetically determined epilepsy. Auditory stimuli are less common precipitants of reflex seizures where sounds may produce seizures in cases of startle epilepsy [2].

Musicogenic epilepsy (ME) is rare and it is considered to be reflex-evoked or sensory-evoked epilepsy. ME is a seizures induced by hearing certain sounds such as a specific type or piece of music. The seizure can be induced also while the subject is exposed to the musical trigger during sleep or merely thinking about it. In other patients, an affective component of the stimulus is obvious, in addition a nonmusical sounds, such as whirring machinery, may be actual causes in others. The prevalence is one case per 10,000,000 populations [26]. It can be underdiagnosed because the latency between stimulus and seizure onset has been found up to several minutes. It occurs more in males than females with the mean age of onset of the seizures is 14 years. This type of seizures was reported in infancy. The most common type of this seizure is a complex partial with secondary generalization with ictal EEG onset in the mesial temporal region. Cerebral single-photon emission computed tomography (SPECT) in a patient with musicogenic epilepsy demonstrated a right temporal focus. The Treatment can be achieved by the use of anti-epileptic drugs or surgical intervention for medically refractory ME with temporal lobe scars and glial temporal lesions [27].

2.4. Movement

Movement-induced reflex seizures such as nonketotic hyperglycemi are reflex seizures most likely to be seen by general neurologists, internists, or other medical specialists in the hospital setting which usually resolve with normalization of the metabolic disturbance. Postanoxic

myoclonus (Lance-Adams) may also represent a movement-induced seizure in the medical patient population [28].

2.5. Complex mental processes

Some of the most unusual and intriguing disorders in neurology are the reflex epilepsies in which seizures are provoked by complex actions or mental processes. Examples of these triggers include reading, eating, micturition, tooth brushing, walking, answering the telephone, and thinking.

Reading epilepsy is an interesting syndrome which was first described in 1956 by Bickford et al. It is characterized by a feeling of movements in the jaw or throat while reading or myoclonic movements of the jaw which may lead to a generalized tonic-clonic seizure when reading remains. Jaw jerks are the most important mark of reading epilepsy but it can also manifest by an abrupt loss of consciousness, blank staring spells, paroxysmal alexia or dyslexia, and prolonged stuttering. In addition a language-related tasks other than reading, such as awkward talking, writing, difficult calculations, playing chess or card games, singing, and recitation can also induce seizures [29]

The underlying cause such as neuroanatomical and biochemical basis of reading epilepsy is not clear. The epileptogenic component of the reading process is different between patients such as eye movements, comprehension, emotional content, speech production, and proprioceptive feedback. A release of endogenous opioids during reading-induced partial seizures in areas of brain involved in normal reading has been found. This directed to the theory that there are networks of cortical areas parallel subserving both cognitive functions and epileptic activity [30]. This is evident by the data from a combined EEG/electromyography-functional MRI study which showed a network of cortical and subcortical areas that are in close proximity with functional areas relevant for language and motor functions has been shown to have significant blood oxygen level dependent changes time-locked with seizure activity [30].

It is important to differentiate between 'primary' or 'specific' reading epilepsy, with seizures only in relation to reading, from a 'secondary', non-specific variety, with seizures when reading. It can be divided into the subgroups idiopathic (primary) and less-frequently seen cryptogenic/symptomatic epilepsy. In primary reading epilepsy, only seizures produced by reading develop without spontaneous seizures.

It occurs more in males with the age of onset is in adolescence and young adulthood. A strong family history of seizures has been stated in 40-50% of patients. EEG is normal in 80% of patients interictally. A spike and wave discharges are seen in 11%, and temporal paroxysmal discharges in 5%. Ictally, 77% have epileptiform discharges consisting of short bursts of sharp waves, spikes, or spike and wave complexes that are bilateral and symmetrical in 32%, bilateral but asymmetrical in 38%, and unilateral or focal in 30%. The seizures are well controlled with valproate, clonazepam, or by modifying the stimulus. The prognosis is usually good [31]

Eating epilepsy rare and it is may cause a seizures that can be triggered by parts of anticipating food, eating itself, or the post-prandial period. It usually occurs in the second decade of life, with a male preponderance. The patients also may have spontaneous seizures. Eating epilepsy

is considered symptomatic epilepsy related to localization. It is localized to temporolimbic, extralimbic, perirolandic, or suprasylvian. In the temporolimbic type, complex partial seizure develops towards the end of the meal. The extralimbic, perirolandic, and suprasylvian types are similar to simple reflex epilepsy and it has a very short latency. Clinically, they may have simple partial seizure, hemiparesis, and mental retardation. The ictal and interictal EEG findings support clinic seizures. The underlying lesion can be due to static encephalopathy, or progressive lesions, like a deep localized glioma. The seizure can be controlled by antiepileptic drug therapy such as clobazam and epilepsy surgery might be considered for refractory patients [32].

3. Conclusion

Various stimuli are important in aggravating reflex seizures. The physiological mechanism in reflex epilepsies is still not well defined. However, the cortical hyperexcitability is the most frequently vital factor. The hyperexcitability of different cortical areas may be due to a genetic tendency or to an acquired lesion. The diagnosis of is reflex epilepsy essential for a well understanding how brain works and management for patients. The study of these seizures will benefit the possible insights of somatomotor processing, language mechanisms and the physiology of ideation. Getting proper history and clinical data from the patient will help in better understanding and managing patients with reflex epilepsy. During the electrophysiological recording of the patient who is believed to have reflex seizures, by giving supposed stimuli, seizure type may be noted and the treatment should be controlled properly. Genetic counseling should be given in patients with strong family history of epilepsy.

Author details

Raidah Saleem AlBaradie

Consultant Pediatric Neurologist/Epileptologist, King Fahd Specialist Hospital-Dammam, Saudi Arabia

References

[1] Striano S, Coppola A, Del Gaudio L, Striano P. Reflex seizures and reflex epilepsies: old models for understanding mechanisms of epileptogenesis. Epilepsy Res. Jun 2012; 100(1-2):1-11.

[2] Kasteleijn-Nolst Trenité DG. Provoked and reflex seizures: surprising or common? Epilepsia. Sep 2012;53 Suppl 4:105-13.

[3] Commission on Classification and Terminology of the International League Against Epilepsy. Proposal for revised classification of epilepsies and epileptic syndromes. Epilepsia 1989;30(4):389-99.

[4] Kasteleijn-Nolst Trenite, DGA. Ictal SPECT in a case of pure musicogenic epilepsy. Photosensitivity in epilepsy: Electrophysiological and clinical correlates. Acta Neurol Scand Suppl. 1989;125:3-149.

[5] Varotto G, Visani E, Canafoglia L, Franceschetti S, Avanzini G, Panzica F. Enhanced frontocentral EEG connectivity in photosensitive generalized epilepsies: a partial directed coherence study. Epilepsia. Feb 2012;53(2):359-67. [Medline].

[6] Groppa S, Siebner HR, Kurth C, Stephani U, Siniatchkin M. Abnormal responses of motor cortex stimulation in idiopathic generalized epilepsy. Epilepsia. 2008;49:2022-2029.

[7] Young NA, Szabo CA, Phelix CF,Flaherty DK, Balaram P, Foust KB, et al. Regional cortical cell reduction in epileptic baboons. Submitted to PNAS.

[8] Garcia-Morales I, Maestu F, Perez-Jimenez MA, Elices E, Ortiz T, Alvarez-Linera J. A clinical and magnetoencephalography study of MRI-negative startle epilepsy. Epilepsy Behav. Sep 2009;16(1):166-71. [Medline].

[9] Batini C, Teillet MA, Naquet R. An avian model of genetic reflex epilepsy. Arch Ital Biol. May 2004;142(3):297-312. [Medline].

[10] Pinto D, Westland B, de Haan GJ, et al. Genome-wide linkage scan of epilepsy-related photoparoxysmal electroencephalographic response: evidence for linkage on chromosomes 7q32 and 16p13. Hum Mol Genet. Jan 1 2005;14(1):171-8. [Medline].

[11] Pinto D, Kasteleijn-Nolst Trenite DG, Cordell HJ, et al. Explorative two-locus linkage analysis suggests a multiplicative interaction between the 7q32 and 16p13 myoclonic seizures-related photosensitivity loci. Genet Epidemiol. Jan 2007;31(1):42-50. [Medline].

[12] Ratnapriya R, Satishchandra P, Dilip S, Gadre G, Anand A. Familial autosomal dominant reflex epilepsy triggered by hot water maps to 4q24-q28. Hum Genet. Nov 2009;126(5):677-83. [Medline].

[13] Brodtkorb E, Michler RP, Gu W, Steinlein OK. Speech-induced aphasic seizures in epilepsy caused by LGI1 mutation. Epilepsia. Jun 2005;46(6):963-6. [Medline].

[14] de Siqueira LF. Progressive myoclonic epilepsies: review of clinical, molecular and therapeutic aspects. J Neurol. Oct 2010;257(10):1612-9. [Medline].

[15] Chuang YC, Chang WN, Lin TK, Lu CH, Chen SD, Huang CR. Game-related seizures presenting with two types of clinical features. Seizure. Mar 2006;15(2):98-105. [Medline].

[16] Covanis A. Photosensitivity in idiopathic generalized epilepsies. Epilepsia 2005;46 Suppl 9:67-72.

[17] Wilkins AJ, Bonanni P, Porciatti V, Guerrini R. Physiology of human photosensitivity. Epilepsia 2004;45 Suppl 1:7-13.

[18] Zifkin BG, Kasteleijn-Nolst Trenité D. Reflex epilepsy and reflex seizures of the visual system: a clinical review. Epileptic Disord 2000;2(3):129-36.

[19] Lu Y, Waltz S, Stenzel K, Muhle H, Stephani U. Photosensitivity in epileptic syndromes of childhood and adolescence. Epileptic Disord 2008;10(2):136-43.

[20] Ricci S, Cusmai R, Fusco L, Vigevano F. Reflex myoclonic epilepsy in infancy: a new age-dependent idiopathic epileptic syndrome related to startle reaction. Epilepsia. Apr 1995;36(4):342-8. [Medline].

[21] Satishchandra P. Hot-water epilepsy. Epilepsia 2003;44 Suppl 1:29-32.

[22] Grosso S, Farnetani MA, Francione S, Galluzzi P, Vatti G, Cordelli DM, et al.. Hot water epilepsy and focal malformation of the parietal cortex development. Brain Dev 2004;26(7): 490-3.

[23] Ilbay G, Sahin D, Ates N. Changes in blood-brain barrier permeability during hot water-induced seizures in rats. Neurol Sci 2003;24(4):232-5.

[24] Savitha MR, Krishnamurthy B, Ashok DA, Ramachandra NB. Self abortion of attacks in patients with Hot Water Epilepsy. Indian Pediatr 2007;44(4):295-8.

[25] Mehta AD, Ettinger AB, Perrine K, Dhawan V, Patil A, Jain SK, et al. Seizure propagation in a patient with musicogenic epilepsy. Epilepsy Behav 2009;14(2):421-4.

[26] Critchley M. Musicogenic epilepsy. Brain 1937;60:13-27.

[27] [47] Tayah TF, Abou-Khalil B, Gilliam FG, Knowlton RC, Wushensky CA, Gallagher MJ. Musicogenic seizures can arise from multiple temporal lobe foci: intracranial EEG analyses of three patients. Epilepsia 2006;47(8):1402-6.

[28] Lance JW, Adams RD. The syndrome of intention or action myoclonus as a sequel to hypoxic encephalopathy. Brain. Mar 1963;86:111-36. [Medline].

[29] Bickford RG, Whean JL, Klass DW, Corbin KB. Reading epilepsy: clinical and electroencephalographic studies of a new syndrome. Trans Am Neurol Assoc. 1956;(81st Meeting):100-2. [Medline].

[30] Koepp MJ, Richardson MP, Brooks DJ, Duncan JS. Focal cortical release of endogenous opioids during reading-induced seizures. Lancet 1998;352(9132):952-5.

[31] Valenti MP, Tinuper P, Cerullo A, Carcangiu R, Marini C. Reading epilepsy in a patient with previous idiopathic focal epilepsy with centrotemporal spikes. Epileptic Disord. Sep 1999;1(3):167-71. [Medline].

[32] Senanayake N. 'Eating epilepsy'-a reappraisal. Epilepsy Res 1990;5(1):74-9.

IntechOpen