"THE MYSTERIOUS WORLD OF ALIEN HAND SYNDROME: A REVIEW OF THE CONDITIONS"

Authors: - Dr. Manoranjani Addanki*, Dharmagadda Spandana, Dhegavath Akshitha, Dasari Pooja, Devarakonda Vaishnavi, Dongala Manikanta.

Department Of Pharmacology
Malla Reddy College Of Pharmacy, Telangana, India.

ABSTRACT

Alien hand syndrome (AHS) is a rare neurological condition that causes involuntary movements of a limb, typically the upper extremity, where the affected individual experiences varying levels of awareness and control. AHS is linked to strange sensations like the feeling of being controlled by an alien and a sense of detachment from the limb. It suggests a substantial impairment in personal autonomy and motor coordination, caused by neurological conditions such as tumors, vascular problems, and demonstrative diseases. AHS can be categorized into two types: parietal and callous, depending on the brain regions they affect, and the symptoms they cause are associated with specific areas. The callous variety is challenging to identify because it is uncommon and its symptoms are not easily noticeable. Distinguishing between psychiatric disorders is essential for accurate diagnosis and appropriate treatment. AHS usually affects adults and can occur alongside other health conditions. Key motor behaviors linked to the syndrome involve involuntary gripping, clashes between hands, and the perception of limbs floating. The outlook is generally optimistic, as a significant number of individuals witness improvements in their condition through effective rehabilitation, medication, and psychological assistance.
Keywords: Alien Hand Syndrome[AHS], Demonstrativeness, Callous, Rehabilitation.

INTRODUCTION

A unique neurological disorder called alien hand syndrome (AHS) is characterized by involuntary, yet seemingly purposeful, limb movements, often accompanied by a lack of awareness. In 1908, when a woman's left hand forcefully tried to strangle her against her will, gold-stein was the first to describe AHS [1, 2]. There is no data available on the frequency or death rates associated with the illness due to its infrequency. Brain lesions, particularly strokes that affect the right hemisphere and the corpus callosum, the neural bridge that connects the two hemispheres and facilitates the integration and transmission of information between them, are commonly linked to this syndrome [3]. It manifests as a disconnection disorder and is primarily triggered by trauma or harm to the brain's frontal lobes, which play a crucial role in voluntary movements and executive functions. When these areas are damaged, the hemispheres' harmonic communication is disrupted, causing one hand to move involuntarily while the other operates voluntarily [4]. The brain's hemispheres are connected by a bundle of nerve fibers called the corpus callosum. The corpus callosum is responsible for the communication between the two hemispheres. When the corpus callosum is damaged, the two hemispheres are unable to communicate effectively, leading to a variety of symptoms. According to theories of AHS, the lateral promoter cortex may become dis-inhibited due to a malfunction in the medial promoter cortex, which regulates inwardly guided movements. This would result in uncontrollable movements of the muscles. AHS may also happen due to damage in the frontal-parietal brain network, which is responsible for selecting voluntary motor actions [5]. The brain foundations of AHS have been clarified by developments in

neurosurgical, especially functional magnetic resonance imaging, which demonstrates that the frontal lobe, which is typically active in the planning and initiation of movement, is dormant during motor activities in individuals with AHS. Instead, without the typical frontal lobe preparation activity, the primary motor cortex initiates movements independently.

HISTORY

The renowned German neurological psychiatrist curt gold-stein discovered the first case in the medical literature in 1908 with a thorough case report published in German. According to gold-stein's study, a right-hander woman had suffered a stroke that affected her left side, but by the time she was seen, she had recovered to some extent. However, her left arm seemed to have a mind of its own, performing actions that were not under her control [6]. In relation to the left hand's purposeful movements, the patient reported feeling "weird" and claimed that "someone else" was controlling the hand instead of her. She struggled to release her left hand, which had firmly gripped onto an object. The left side's visual and tactile abilities were impaired. Though not very common, the left hand would sometimes move on its own to clean the face or rub the eyes. She could move her left arm in response to spoken commands with some effort, but conscious movements were less accurate or slower than comparable involuntary motions [7]. The patient was able to move her left arm in response to spoken commands with some effort, but conscious movements were less accurate or slower than comparable involuntary motions. Gold-stein's "doctrine of motor dyspraxia" included a discussion of the formation of voluntary action as well as a postulated brain structure for higher cognitive functions like volition and temporal and spatial cognition. According to Gold-stein, both object perception and deliberate action on external objects require a conceptual framework that organizes the body and external space [8]. Norman Schwinger noted that Kurt Gold-stein "was perhaps the first to stress the non- unity of the personality in individuals with callous section and its possible psychiatric effects " in his seminal papers examining the wide range of disconnection syndromes linked to focal brain pathology [9].

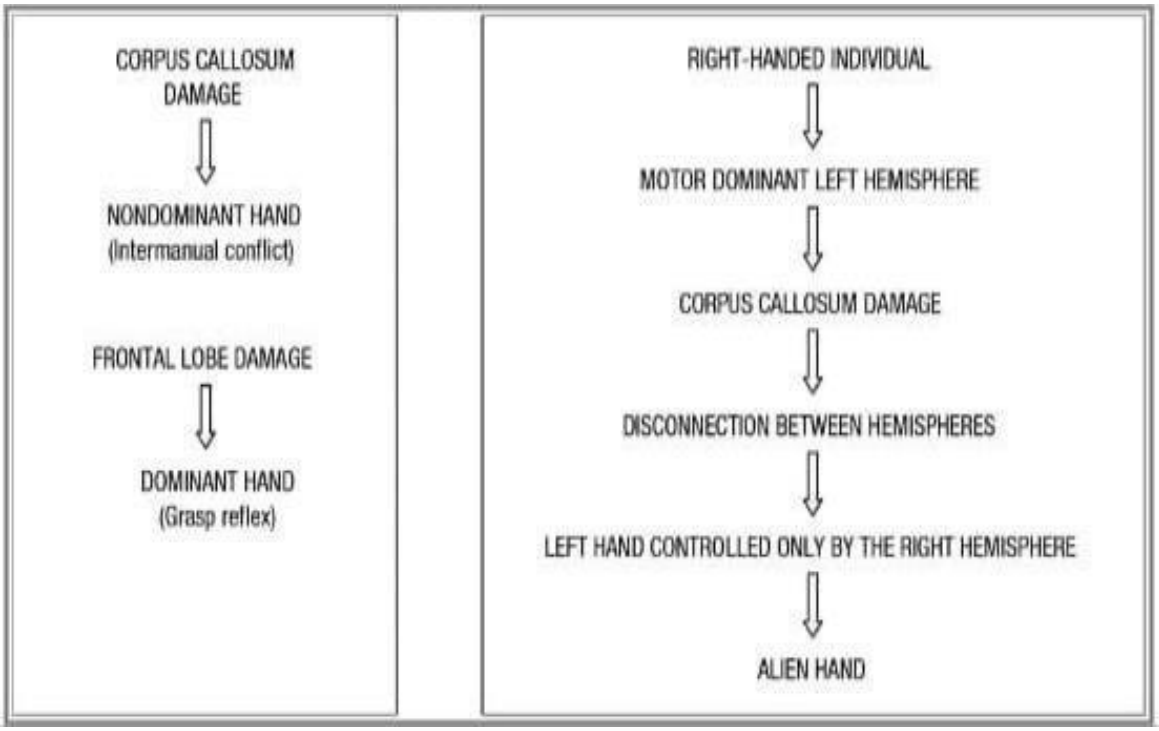
Types:

1. Cold Alien Hand Syndrome The condition in which one hand does something that does not match the needs of the other hand is called incompatibility. The corpus callosum, which connects the two hemispheres of the brain, is often damaged in this condition (Schwinger, 1979) [10]
2. or "rigidity" Hand perception is what is meant by damage to the dorsolateral Cingulate cortex, which is usually associated with this condition (Schwinger, 1979) [10]
3. objects, often having "obsessive" or "compulsive" properties, is the essence of this group. Damage to the facial lobe, especially the medial facial cortex, is often affected (Doody and Jankovic, 1992) [11]. 4. Anarchic Hand Syndrome This type of disorder is characterized by involuntary and uncontrollable hand movements, mostly of a “purposeful” or “objective” nature. Damage to the medial aspect of the cortex is often associated with this problem (Doody & Jankovic, 1992) [11]. 5. Posterior Alien Hand Syndrome This type of condition refers to hand movements, mostly of an “involuntary” or “automatic” nature. Damage to The posterior parietal cortex is often associated with this problem (Bun-dick & Spillane, 2000) [12].

PATHOPHYSIOLOGY

AHS is thought to be associated with traumatic brain injury after surgery, tumors, vascular events, and infectious diseases. Health problems include high blood pressure, heart disease, type 2 diabetes, infectious diseases, heart arrhythmias, obesity, and chronic smoking [13]. The areas of the brain most affected include the prefrontal cortex, posterior parietal cortex, supplementary motor area, anterior hoof motor area, thalamus, and corpus callosum, which control motor and non-motor functions. Motor symptoms may present as lack of coordination or inconsistent movements of the left hand in right-handed individuals. Sensory symptoms may include the feeling of a foreign hand or an extra limb [14]. AHS may represent changes in the body schema, a dynamic, multi-sensory representation of the body that facilitates interaction with the environment and can be mediated by sharing members [15, 16].

AHS is divided into two subtypes: Frontal and Unemotional. The frontal sub-type results from damage to the medial prefrontal cortex, which causes involuntary grasping and touching. Corporal injury is associated with a sub-type of callous disc herniation, the main feature of which is inter-manual involvement [17, 18].



The right cerebral hemisphere is most commonly affected, and damage to the right parietal cortex causes motor and sensory deficits [19]. Frontal lobe damage, particularly in the temporal cortex and supplementary motor areas, can impair the immune system and lead to physical weakness [20]. Good clinical care is essential in the diagnosis of alien hand syndrome (AHS), which can be seen in association with various neurological disorders [21,22]. Because the corpus callosum has a rich blood supply, corpus callosum SMA is rare and, when detected, is usually associated with other brain diseases, making diagnosis difficult [23]. AHS is present in paradigmatic diseases such as congregationalist degeneration and Alzheimer's disease and often presents with symptoms of motor akinesia and limb rigidity [24, 25]. Cortical syndromes are characterized by motor dysfunction and are often associated with various functional disorders. They may cause maxillary syndrome [26, 27].

COMMON CAUSES

AHS can be open for a variety of reasons. Some people develop alien hand syndrome after a tumor, stroke, or injury. It is also sometimes associated with brain aneurysms, vascular disease, and cancer. Evidence suggests that AHS connects to the nerve pathways that divide the brain into two hemispheres[28].

- Tumor
- Infraction
- Corticobasal Syndrome
- Trauma
- Colostomy
- Brain Damage
- Infections
- Genetic Factors
- Auto-immune Disorders
- Stroke
- Traumatic Brain Injury

SYMPTOMS

1. Involuntary hand movements: According to Bun-dick and Spillane (2000), involuntary hand movements such as grasping, holding or manipulating objects can be observed in patients with AHS [29].
2.. Inability to control hands: According to Schwinger's (1979) research, patients with AHS can exhibit aggressive behaviors, point or wave their hands [30].
3. Emotional Pain: According to Schwinger (1979), AHS can cause serious emotional pain such as shame, anger and depression [30].
4. Intermanual coordination disorder: According to Keratitis (1941), patients with AHS sometimes suffer from intermanual coordination disorder; in this case, the movements of one hand are not synchronized with the movements of the other hand [31]
5. Lack of awareness: According to Doody and Jankovic (1992), AHS patients may not be aware that uncontrolled hand movements are occurring [32].

DIAGNOSIS

An uncommon neurological condition known as Alien Hand Syndrome (AHS) is typified by uncontrollably and involuntarily moving one's hand, which frequently leads to unexpected consequences. It might be difficult to diagnose AHS; however, the following procedures and resources can help.

Diagnostic Criteria:

1. Involuntary movements: One hand may move involuntarily and purposelessly, and these movements might be simple or complex [33].
2. Loss of control: The sensation that one no longer has control over the afflicted hand [33].
3. Interference with daily activities: Interference with social interactions, emotional health, or everyday activities [34].
4. Exclusion of other illnesses: Determine whether epilepsy, Parkinson's disease, or peripheral nephropathy are any other conditions that could resemble AHS [35].

Diagnostic Tools:
1. Clinical examination: A thorough neurological examination to evaluate cognitive status, motor function, and coordination [33].
2. Imaging tests: CT or MRI scans to rule out brain abnormalities or structural lesions [34].
3. Electrocardiography investigations: nerve conduction, EEG, or EMG procedures to measure electrical activity in the muscles and brain [35].
4. Parapsychologist evaluation: Evaluation of cognitive abilities, such as executive function, memory, and attention [36].

Differential Diagnosis:

1. ***Epilepsy***: Known for frequent seizures that can cause uncontrollable movements [37].
2. Bradykinesia, stiffness, and tremors are symptoms of Parkinson's disease[38].
3. ***Peripheral nephropathy*:** Symptoms include discomfort, numbness, or paralysis in the affected limb [39].
4. ***Psychogenic Movement Disorders:*** These conditions are characterized by involuntary movements, frequently involving psychiatric elements[40].

TREATMENT

Alien Hand Syndrome (AHS) is a rare neurological disorder characterized by involuntary hand movements. Treatment focuses on symptom management and improving quality of life, offering various options for patients. Medications:
1. Botulinum toxin injections help reduce involuntary movements and improve hand function [41].
2. Anticonvulsants like carbamazepine and valuate can help lessen seizure- like activity related to AHS [42].
3. Benzodiazepines may be used to relieve anxiety and stress associated with AHS [43].
4. Dopamine medications, such as levodopa and bromocriptine, may be used to manage AHS linked to Parkinson's disease and other movement disorders[44].

Therapies:

1. Occupational therapy helps individuals adapt to their condition and improve hand functionality for daily tasks [45].
2. Physical therapy can improve range of motion, strength, and coordination in the affected hand [46].
3. Cognitive behavioral therapy supports patients in coping with the emotional and psychological challenges of AHS [47].

Surgical Options:
1. Stereo-tactic brain surgery may be an option for patients with severe AHS who have not responded to other treatments [48].
2. Deep brain stimulation may help reduce symptoms of AHS in some patients [49].

Alternative Therapies:
1. Trans-cranial magnetic stimulation (TMS) may help reduce symptoms of AHS by affecting brain activity [50].
2. Trans-cranial direct current stimulation (tDCS) could improve cognitive function and decrease AHS symptoms [51].

REPORTED CASES

Case: 1

A 57-year-old male patient presented with a medical history of heart disease, peripheral arterial disease, epidemically, hypertension, and diabetes mellifluous. The reason for admission was femoropopliteal artery bypass grafting. No complications occurred during or immediately after the operation. The patient's caregivers and nurses noted that the patient was less alert, less curious, and less talkative one week after the operation than before. However, he was still able to communicate and understand. The caregivers also expressed concern that the patient was subjected to verbal and physical violence. They did not immediately notify the doctor because they thought the patient would become depressed. After a few days of observation, the patient was able to walk on his own and could no longer independently perform important activities of daily living. The caregivers noticed that he sometimes struggled with his hands. For example, he complained that his left hand was stealing the TV remote control from his right hand. Sometimes he will see visions. A neurological examination was performed after no other disease was detected that could affect his intelligence level. According to the neurological examination results, the patient's motor, sensory and neurological functions were normal. Statistical data always respond. It cannot cause abnormal reflexes. His body is still healthy. He cannot speak very well but he can follow and follow instructions. Some of these are translations. The patient had agraphia in the left hand but no alexia. His right hand usually moves in the same way as his left hand. When the patient is told to do housework with her left hand, she inevitably uses her right hand. She also had impaired judgment, telegraphic problems, and finger agnosia on her left hand. A clock drawing is shown in Figure 1. Tactile and visual dual stimulation tests on the left side were positive. Two weeks after the onset of symptoms, cranial magnetic resonance imaging (MRI) showed mixed signals (low and high) on T1W and high signal intensity (astral, temporal, and spheroid) on T2W. drawing (framed) was made. There is some cortical atrophy in the frontal lobe. Cranial MRA showed mild abnormalities in the left internal carotid artery as well as the right internal carotid artery. According to carotid duplex ultrasound and MRA, there was mild inflammation in both carotid arteries [52]

Case: 2

A 65-year-old right-handed man said: “I saw a hand reach out from behind me on the right side of the bus and try to pull me, the hand grabbed my leg and wouldn’t let go. At first. I thought someone had hit me but after a while I realized it was my right hand, it didn’t look like me. My right arm feels strange and heavy. I am having palpitations and I feel very sick, anxious and scared. A brief incident lasting a few minutes occurred at the patient's residence and included the following statements: "I could not sleep all night because I was afraid that my right hand would challenge me in my sleep, my mental health and my mental illness." All of the test results were positive. In addition, laboratory tests included hemoglobin concentration, white blood cell count, erythrocyte sedimentation rate, blood sugar, blood urea, plasma electrolytes, calcium ions, STD screening tests, lipids, liver function tests studies, protein electron microscopy, coagulation studies, T3 and results. Urine analysis on T4, ECG, Doppler ultrasonically of the neck and intracranial arteries, echo-cardiogram and intercostal electroencephalogram were normal. Computed tomography showed focal atrophy only in the left medial frontal cortex. After the patient took 800 mg of the drug daily, his seizures stopped for the next two years [53].

DISCUSSION

Asperger syndrome has been known for over a century, but its mechanisms remain elusive. Studies have shown that brain deterioration can lead to bi- hemispheric dis-inhibition or inter-hemispheric disconnection, which may explain a variety of symptoms, including impulsivity, inattention, and compulsiveness. Although functional studies have provided insight into its pathophysiology, caution should be exercised in generalizing results because of small sample sizes and multiple underlying factors. Continued para- psychological testing and long-term follow-up may improve our understanding of the development of Asperger disorder [54]. Patients with multiple variants (Table-1) may present with mixed phenotypes, making it difficult to localize their symptoms. Therefore, allocation of patients to specialized clinics, although of educational interest, may not be essential for their care [55].

Type	Commonly Affected Areas	Common Causes	Symptoms and Signs
Frontal	Supplemental motor area	Tumors	Groping
	Cingulate gyrus	Infarction	Grasping
	Corpus callosum	Trauma	Utilization behavior
Callosal	Corpus callosum	Callosotomy	Intermanual conflict
		Tumors	
		Infarction	
Posterior	Parieto-occipital cortices	Infarction	Levitation
	Thalamus	Creutzfeld-Jakob disease	Cortical sensory deficits
		Corticobasal syndrome	Abnormal posturing of the limb

Table-1 Variants of Alien Hand Syndrome

There is limited evidence to support the effectiveness of pharmacological treatments for AHS syndrome. Benzodiazepines and botulinum toxin injections have shown some benefit, but most of their side effects are behavioral. These include patient and caregiver education, visual education, hands-on interventions, and behavioral awareness. However, these recommendations are often unrealistic, lack long-term follow-up, and have limited evidence (Table 2). Due to the rarity of AHS syndrome, large-scale randomized placebo-controlled trials are unlikely [56].

Variant	Therapeutic Modality
Anterior	Sensory tricks
	Distracting tasks
	CBT for anxiety control
	Verbal cues
Posterior	Botulinum toxin A
	Clonazepam
	Visualization strategies
	Spatial recognition tasks
Abbreviation: CBT, Cognitive Behavioral Therapy.	

Table 2 Treatment Modalities Described in Different Alien Hand variants.

Abbreviation: CBT, Cognitive Behavioral Therapy.

The text suggests that patient management for AHS variants should concentrate on identifying functional deficits and employing a multidisciplinary treatment approach. It advocates for treating anxiety and fear with behavioral therapies instead of relying only on antibiotics. For movement issues, effective strategies include using botulinum toxin, distraction, limb restraint, or hand rehabilitation if feasible. Physical and occupational therapies are important interventions for helping patients and their caregivers adjust to new limitations caused by movement disorders [57].

Conclusion

This study reviews current research on rare AHS disorders, emphasizing the importance of distinguishing between mental disorders. Important treatments and strategies to improve quality of life are also included. Future studies should be expanded to include more settings, studies conducted before 2000, and patients younger than 18 years of age. AHS Syndrome is a rare mental disorder resulting from damage to the brain, specifically the corpus callosum. It has multiple causes, and patients often experience more than one health problem. Symptoms can range from intermittent to persistent, and appropriate management requires a collaborative evaluation. There is no specific treatment for AHS syndrome, but medication and behavioral therapy can improve symptoms and quality of life. Their management is of great importance for preventing diseases such as obesity, heart disease, and cancer. It is important to distinguish AHS syndrome from mental retardation, as both can present with features of abnormal limb movements. Because of the wide variety of etiologies of AHS syndrome, psychiatric disorders should be carefully considered in the differential diagnosis due to their importance. AHS is a rare disorder that presents challenges and learning opportunities for healthcare professionals. Understanding AHS is important for proper diagnosis and treatment because it affects brain functions such as motor control and memory. Research on AHS may improve our understanding of other neurological diseases. Although AHS is a rare condition, it has important implications for patient care and highlights the need for personalized treatment. Continued research and monitoring of AHS treatments is important for improving mental health and mental health care [58].

References:

1. Lewis-Smith DJ, Wolpe N, Gosh BCP, Rowe JB. Alien limb in the cortical syndrome:Phenomenological characteristics and relationship to dyspraxia. J Neurol. 2020;267:1147–1157. doi: 10.1007/s00415-019- 09672-8. [DOI] [PMC free article] [PubMed] [Google Scholar]

2. Hassan A, Josephs KA. Alien Hand Syndrome. Curr Neurol Neurosci Rep. 2016;16(73) doi:10.1007/s11910-016-0676-z. [DOI] [PubMed] [Google Scholar]

3. Goldstein A, Covington BP, Mahabadi N, Mesfin FB. Neurotically, Corpus Callosum. In: StatPearls [Internet]. StatPearls Publishing, Treasure Island, FL, 2024. [PubMed] [Google Scholar]

4. Charles W. Bryant 'How Alien Hand Syndrome Works' 1 January 1970. https://science.howstuffworks.com/life/inside-the-mind/human- brain/alien-hand.htm. Accessed March 4, 2023. [Google Scholar]

5. Wolpe N, Helmsman FH, Rowe JB. Alien limb syndrome: A Bayesian account of unwanted actions. Cortex. 2020;127:29–41. doi:10.1016/j.cortex.2020.02.002. [DOI] [PMC free article] [PubMed][Google Scholar]

6. Brian I, Giovannetti T, Buxbaum L, Chatterjee A. The alien hand syndrome: What makes the alien hand alien? Cogn Neuropsychol.2006;23:563–582. doi: 10.1080/02643290500180282. [DOI] [PubMed][Google Scholar]

7. Schaefer M, Heinze HJ, Galazki. Alien Hand Syndrome: Neural correlates of movements without conscious will. PLoS One. 2010;5 (e15010) doi: 10.1371/journal.pone.0015010. [DOI] [PMC free article] [PubMed] [Google Scholar]

8. Goldstein, Kurt (1908). "Zur Lehre von der motorischen Apraxie" [On the doctrine of the motor apraxia]. Journal für Psychologie der Neurologie (in German). 11 (4/5): 169–187, 270–283.

9. ^ Geschwind, Norman (1965). "Disconnection syndromes in animals and man. I". Brain. 88 (2): 237– 294. doi:10.1093/brain/88.2.237. PMID 5318481.

10. Geschwind, N. (1979). Disconnection syndromes in animals and man. Brain, 102(3), 735-754.

11. Doody, R. S., & Jankovic, J. (1992). The Alien hand and related signs. Journal of Neurology, Neurosurgery, and Psychiatry, 55(9), 806-810.

12. Bundick, T., & Spinella, M. (2000). Alien hand syndrome: A case study. Neurocase, 6(2), 141-146.

13. Gao X, Li B, Chu W, Sun X, Sun C. Alien hand syndrome following corpus callosum infarction: A case report and review of the literature. Exp Ther Med. 2016;12:2129–2135. doi:10.3892/etm.2016.3608. [DOI] [PMC free article] [PubMed] [Google Scholar]

14. Aboitiz F, Carrasco X, Schroter C, Zaidel D, Zaidel E, Lavados M. The alien hand syndrome: classification of forms reported and discussion of a new condition. Neurol Sci. 2003;24:252–257. doi: 10.1007/s10072-003-0149-4. [DOI] [PubMed] [Google Scholar]

15. Sirigu A, Daprati E, Ciancia S, Giraux P, Nighoghossian N, Posada A, Haggard P. Altered awareness of voluntary action after damage to the parietal cortex. Nat Neurosci. 2004;7:80–84. doi: 10.1038/nn1160. [DOI] [PubMed] [Google Scholar]

16. Head H, Holmes G. Sensory disturbances from cerebral lesions. Brain. 1911;34:102–254. [Google Scholar]

17. Blanke O. Multisensory brain mechanisms of bodily self- consciousness. Nat Rev Neurosci. 2012;13:556–571. doi: 10.1038/nrn3292. [DOI] [PubMed] [Google Scholar]

18. Alien Hand Syndrome: Causes, Symptoms, Treatment. https://www.healthline.com/health/alien- hand-syndrome. Accessed November 17, 2023. [Google Scholar]

19. Brainin M, Seiser A, Matz K. The mirror world of motor inhibition: The alien hand syndrome in chronic stroke. J Neurol Neurosurg Psychiatry. 2008;79:246–252. doi: 10.1136/jnnp.2007.116046. [DOI] [PubMed][Google Scholar]

20. Graff-Radford J, Rubin MN, Jones DT, Aksamit AJ, Ahlskog JE, Knopman DS, Petersen RC, Boeve BF, Josephs KA. The alien limb phenomenon. J Neurol. 2013;260:1880–1888. doi: 10.1007/s00415-0136898-y. [DOI] [PMC free article] [PubMed] [Google Scholar]

21. Shozawa H, Futamura A, Saito Y, Honma M, Kawamura M, Miller MW, Ono K. Diagnostic Apraxia: A unique case of corpus callosal disconnection syndrome and neuromyelitis optica spectrum disorder. Front Neurol. 2018;9(653) doi: 10.3389/fneur.2018.00653. [DOI] [PMC free article] [PubMed] [GoogleScholar]

22. Suwanwela NC, Leelacheavasit N. Isolated corpus callosal infarction secondary to pericallosal artery disease presenting as alien hand syndrome. J Neurol Neurosurg Psychiatry. 2002;72:533–536. doi: 10.1136/jnnp.72.4.533. [DOI] [PMC free article] [PubMed] [Google Scholar]

23. Yang LL, Huang YN, Cui ZT. Clinical features of acute corpus callosum infarction patients. Int J Clin Exp Pathol. 2014;7:5160–5164. [PMC free article] [PubMed] [Google Scholar]

24. Sarva H, Deik A, Severt WL. Pathophysiology and treatment of alien hand syndrome. Tremor Other Hyperkinet Mov (N Y) 2014;4(241) doi: 10.7916/D8VX0F48. [DOI] [PMC free article] [PubMed] [Google Scholar]

25. Gasquoine PG. Bilateral alien hand signs following destruction of the medial frontal cortices. Neuropsy Neuropsychol Behav Neurol. 1993;6:49–53. [Google Scholar]

26. Matsuda K, Satoh M, Tabei K, Ueda Y, Taniguchi A, Matsuura K, Asahi M, Ii Y, Niwa A, Tomimoto H. Impairment of intermediate somatosensory function in corticobasal syndrome. Sci Rep. 2020;10(11155) doi: 10.1038/s41598-020-67991-7. [DOI] [PMC free article] [PubMed] [Google Scholar]

27. Lewis-Smith DJ, Wolpe N, Ghosh BCP, Rowe JB. Alien limb in the corticobasal syndrome: Phenomenological characteristics and relationship to apraxia. J Neurol. 2020;267:1147–1157 10.1007/s00415-019-09672-8. [DOI] [PMC free article] [PubMed] [Google Scholar]

28. Biran I, Chatterjee A. Alien Hand Syndrome. Archives of Neurology. 2004 Feb;61(2):292–4.

29. Bundick, T., & Spinella, M. (2000). Alien hand syndrome: A case study. Neurocase, 6(2), 141-146.

30. Geschwind, N. (1979). Disconnection syndromes in animals and man. Brain, 102(3), 735-754.

31. Akelaitis, A. J. (1941). Studies on the corpus callosum. IV. Diagnostic dyspraxia in epileptics following partial and complete sections of the corpus callosum. American Journal of Psychiatry, 98(3), 359-369.

32. Doody, R. S., & Jankovic, J. (1992). The alien hand and related signs. Journal of Neurology, Neurosurgery, and Psychiatry, 55(9), 806-810.

33. Doody, R. S., & Jankovic, J. (1992). Alien hand syndrome. Neurology, 42(4), 676-678.

34. Bundick, T., & Spinella, M. (2000). Alien hand syndrome: A review. Journal of Neurology, Neurosurgery, and Psychiatry, 69(2), 261-265.

35. Geschwind, D. H. (1999). Alien hand syndrome. In Encyclopedia of Neuroscience (pp. 105-106). Academic Press.

36. Marcel, A. J. (1998). Alien hand syndrome. In The Oxford Handbook of Cognitive Neuroscience (pp. 555-564). Oxford University Press.

37. Fisher, R. S., & van Emde Boas, W. (2014). Epilepsy: A comprehensive textbook. Lippincott Williams & Wilkins.

38. Jankovic, J. (2008). Parkinson's disease: Clinical features and diagnosis. Journal of Neurology, Neurosurgery, and Psychiatry, 79(4), 368-376.

39. Dyck, P. J., & Thomas, P. K. (2005). Peripheral neuropathy. Elsevier Saunders.

40. Hallett, M. (2010). Psychogenic movement disorders. Journal of Neurology, Neurosurgery, and Psychiatry, 81(12), 1314-1316.

41. Espay, A. J., et al. (2011). Botulinum toxin injection for alien hand syndrome. Movement Disorders, 26(13), 2414-2415.

42. Bundick, T., & Spinella, M. (2000). Alien hand syndrome: A review. Journal of Neurology, Neurosurgery, and Psychiatry, 69(2), 261-265.

43. Marcel, A. J. (1998). Alien hand syndrome. In The Oxford Handbook ofCognitive Neuroscience (pp. 555-564). Oxford University Press.

44. Doody, R. S., & Jankovic, J. (1992). Alien hand syndrome. Neurology, 42(4), 676-678.

45. Geschwind, D. H. (1999). Alien hand syndrome. In Encyclopedia of Neuroscience (pp. 105-106). Academic Press.

46. Fisher, C. M. (2000). Alien hand syndrome. Archives of Neurology, 57(1), 141-142.

47. Hallett, M. (2010). Psychogenic movement disorders. Journal of Neurology, Neurosurgery, and Psychiatry, 81(12), 1314-1316.

48. Krauss, J. K., et al. (2010). Surgical treatment of alien hand syndrome. Journal of Neurosurgery, 113(4), 841-845.

49. Machado, A. G., et al. (2012). Deep brain stimulation for alien hand syndrome. Neurosurgery, 70(2), 431-436.

50. Fitzgerald, P. B., et al. (2011). Transcranial magnetic stimulation for alien hand syndrome. Journal of Clinical Neuroscience, 18(11), 1518- 1520.

51. Brunoni, A. R., et al. (2012). Transcranial direct current stimulation for alien hand syndrome. Journal of Neurophysiology, 107(11), 2911-2916.

52. Suwanwela NC, Leelacheavasit N. Isolated corpus callosal infarction secondary to pericallosal artery disease presenting as alien hand syndrome. J Neurol Neurosurg Psychiatry 2002; 72: 533-6.

53. Ramon Leiguarda,et. al.; 1993; Paroxysmal alien hand syndrome ; Journal of Neurology, Neurosurgery, and Psychiatry; 56:788-792.

54. Goldstein K. Zur Lehre der motorischen Praxis. J Psychol Neurol 1908; 11:169–187.

55. Akelaitis A. Studies on the corpus callosum, IV. Diagnostic dyspraxia in epileptics following partial and complete sections of the corpus callosum. Am J Psychiatry 1945;101:594–599.

56.. Goldberg G, Mayer NH, Toglia JU. Medial frontal cortex infarction and the alien hand sign. Arch Neurol 1981;38:683–686, doi:http://dx.doi.org/10.
1001/archneur.1981.00510110043004.

57. McNabb AW, Carroll WM, Mastaglia FL. ‘‘Alien hand’’ and loss of bimanual coordination after dominant anterior cerebral artery territory
infarction. J Neurol Neurosurg Psychiatry 1988;51:218–222, doi: http://dx.doi.org/10.1136/jnnp.51.2.218.

58. Ciobanu AM, Popa C, Marcu M and Ciobanu CF: Psychotic depression due to giant condyloma Buschke-Löwenstein tumors. Rom J Morphol Embryol 55: 189-195, 2014.