Review Article

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A CRITICAL APPRAISAL OF AUTISM SPECTRUM DISORDER IN TERMS OF AYURVEDA

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ABSTRACT

Introduction: Autism spectrum disorders are conditions characterised by impaired social interaction communication skills and associated stereotypic, restrictive and repetitive behavioural patterns. According to a WHO report, it is estimated that worldwide, about one in 100 children has ASD. In India, according to the calculation of the Rehabilitation Council of India, the prevalence rate is 1 in 500 or 0.2%. Multimodal management approach of Ayurveda comprising herbal supplements, Ayurveda compounds, and panchakarma therapies. In Ayurvedic literature, Acharyas mention three types of chikitsa for the whole body and mind level- daivavyapashraya, yuksivyapashraya and satvavjaya chikitsa. These treatments benefit autistic children by a different mechanism of action and improve their quality of life. It concluded that Ayurveda provides safe, effective, cheap and untoward effect-free management along with enhancing the quality of life for people living with ASD and bringing back smiles on parents' faces.

Keywords: Autism Spectrum Disorder, Daivavyapashraya Chikitsa, Yuktivyapashraya Chikitsa, Satvavjaya Chikitsa, Medhya drugs, Panchakarma therapies.

INTRODUCTION

Autism spectrum disorders are conditions characterised by the impairment of social interaction, communication (both verbal and nonverbal) skills and associated stereotypic, restrictive and repetitive behavioural patterns. According to a WHO report, it is estimated that about one in 100 children has ASD [1]. In India, according to the calculation of the Rehabilitation Council of India, the prevalence rate is 1 in 500 or 0.2% [2]. The aetiology of Autism spectrum disorder is multifactorial, with genetic and non-genetic factors; it is the combination of genetic, environmental and neurodevelopment factors. Along with these factors in autistic children, there is the presence of altered gut microbes (dysbiosis), other GI disorders, and deranged metabolism and accumulation of toxic substances.

According to Ayurveda, Autism is understood in two ways; one is biological, that the problem is related to kostha (gastrointestinal disorders, gut dysbiosis or dhatu derangement of metabolism and production of neurotoxin), and the other one is metaphysical or at the level of atma, manas, buddhi. There is apkava parinam both in kostha and dhatu levels, and there is production of ama in both levels and improper rasa dhatu is formed. On considering another level, the knowledge of gyan is attained by the proper association of indriya, indriyartha, manas and atma. Any derangement in this process leads to the absence of knowledge, so the patient cannot respond to social stimuli, leading to behavioural disorders, also seen in Autism. The pathophysiology of Unmad resembles Autism; in both, there is derangement of manas, buddhi, sangya, gyan, smriti, bhakti, sheela, and chesta and aachar [3]. The symptoms of Unmad can be considered as autistic behaviour manovibhramam- mental confusion, budhivibhramam- impaired intelligence, sangya gyan vibhramam- impaired consciousness, smritivibhramam- impaired memory, bhaktivibhramam- impaired or inappropriate desire, loss of innate quality of self-realisation, sheelavibhramam- inappropriate manners and behaviour (repetitive behaviour and restricted behaviours), chestavibhramam- motor clumsiness and motor stereotypic activities, acharvibhramam- couldn't follow rituals and ways in the family and society. For treating ASD, we should treat koshta, dhatu and the level of buddhi. Amapachana and Agni chikitsa, along with pathya ahar- vihara (does and don'ts), will be the mainstay of treatment at the koshta level while equilibrium among vitiated in manasika doshas can be maintained through medhya drugs single or in combination form along with some panchakarma procedures like shirodhara, shiropichu etc.

Ayurvedic Management of Autism Spectrum Disorders (ASD)

Ayurveda approach to managing ASD is a holistic approach with due importance to logic-based pharmacotherapy, panchakarma intervention and psychotherapy in the form of spiritual and psychological interventions. In Ayurvedic literature, Acharyas mentioned three chikitsa types: daivavyapashraya, yuksivyapashraya and satvavjaya chikitsa[4].

Chikitsa Daiva-Vyapashraya (Spiritual Therapy)

Ayurveda views individuals as part of the supreme conscience, and the significance of spirituality has been thoroughly discussed in numerous contexts. Logical use of mantra, aushadhi

(medicines), mani (wearing gems), bali (auspicious offerings), upahara (gifts to people), homa (oblations), niyama (observance of scriptural rules), prayarshchitta (atonement), upvasa (fasting), svastyayana (chanting of auspicious hymns), pranipatagamana (obeisance to the gods, going to pilgrimage), etc. are aimed at boosting the self-confidence and mental strength to the individuals.

Satvavajaya Chikitsa

This term refers to managing the mind so that it is not influenced by various stressors that make it susceptible to pragyapradha. satvavajaya, according to Acharya Charaka, is the disengagement of the mind from impure objects. mano nigraha: controlling the mind and protecting it from unhealthy relationships. dhee-dhairyaatmadi vigyanam: it offers a more profound comprehension that, in turn, aids in improved mental control.

Yuktivyapashraya Chikitsa

This entails providing care through the rational application of medication and adapting ahara and vihara to the needs of the individual. The patient should be urged to adopt a healthy diet, adhere to sadvrita's guidelines, and employ medhya rasayana (brain supplements) and doshahara ausadha (medications) to manage their unbalanced thoughts.

Single Herbs

Brahmi (*Bacopa monnieri*)

Brahmi is a medhya medication with nootropic effects that is suggested for several psychosomatic and mental illnesses. By increasing the effectiveness of nerve impulse transmission and strengthening memory and cognition, bacoside, the active ingredient in Brahmi, is responsible for improving memory-related functions. The substances Bacoside A and B5 are in charge of the cognitive effects. It is a crucial plant that prevents forgetfulness and enhances memory. Brahmi improves memory, boosts intelligence and speech, and corrects an autistic person's abnormalities in emotions, personality, and mood.

The *in-vivo* study indicated that *Bacopa monnieri* at 80 mg/kg ameliorated abnormal behavioural paradigms such as social deficits, repetitive behaviour, learning and memory impairments and motor coordination exhibited by the VPA model of ASD in rats[6]. Antioxidant, anti-inflammatory, anticonvulsant, cardiotonic, bronchodilator and peptic ulcer protection are its chief pharmacological effects. Brahmi is used for several purposes in Ayurvedic medicine, including memory enhancement, epileptic treatment, insomnia treatment, and anxiolytic treatment. Its impact on memory function focuses more on reducing forgetfulness than on enhancing learning.[7]

Sankhpushpi *(Convolvulus prostratus)*

Sankhpushpi is a well-known Ayurveda herb reported as a brain tonic, nervine tonic and laxative. *Convolvulus prostratus* belongs to the Convolvulaceae family and is ubiquitous in the northwestern regions of India[8]. Recent studies on Shankhpushpi found it possesses antioxidant and anti-apoptotic properties and protects from H_2O_2-induced cytotoxicity, plasmid DNA damage, and telomer damage[9]. This herb's traditional Ayurvedic description is as a memory and cognition enhancer. Additionally, it is utilised in a variety of formulations for the treatment of nerve disorders, including psychosis, hysteria, epilepsy, and sleeplessness[10]. Mechanistically, it reduces spontaneous motor activity, thereby controlling the refluxes and frightening responses. It ultimately acts as a sedative moiety, which initiates a persistent fall in blood pressure and cardiac contraction, thereby managing neurological pathologies, such as anxiety, insanity and epilepsy[11]. In ancient writings, this plant has been called sara, medhya, vrsya, and rasayana. These names refer to the herb's laxative, nootropic, aphrodisiac, and rejuvenator effects. The juice of *Bacopa monnieri* (Brahmi), *Acorus calamus* (Vacha), and *Saussurea lappa* (Kushtha), as well as the white-flowered variety of *C. prostratus* (Shankhpushpi), were also employed by Acharya Charaka, one of the renowned ancient Indian physicians, to treat epilepsy and insanity. Similar viewpoints were expressed in Chakradatta's Chikitsasangraha, Kaideva Nighantu's Ayurveda Saar Sangraha, and others[12]. To give this plant its nootropic properties, *C. prostrates* (CP) contain volatile oil, fatty alcohols, flavonoids including kaempferol, hydroxycinnamic acid and sitosterol, and carbohydrates like glucose, rhamnose, sucrose, etc. Convoluvine, an alkaloid in this herb, has also been discovered to block cholinergic muscarinic receptors M2 and M4. Convolvine also aids in potentiating the effect of another muscarinic memory enhancer, namely, arecoline, thereby imparting nootropic abilities to CP13. In a study, Rawat and Kothiyal have also found that the aquo-methanolic, ethanolic and petroleum ether extracts isolated from CP (50–400 mg/Kg) exhibited anxiolytic, memory-enhancing and nootropic activity as evaluated by using Elevated Plus Maze (EPM) and step-down models in mice. EPM test has mainly been used to investigate the interactions between aversive memory and anxiety responses of the mice. CP effects on EPM activity are comparable to the standard of care drug, Piracetam[14]. Acetylcholinesterase (AChE) activity in the cortex and hippocampus of male Wistar rats that had taken scopolamine was suppressed by the aqueous extract of the roots of *C. prostratus*. Additionally, the cortex and hippocampus levels of glutathione reductase, superoxide dismutase, and reduced glutathione increased as a result of the CP extract's apparent antioxidant activity.[15]

Yastimadhu (*Glycyrrhiza glabra)*

The Indian *Ayurvedic* system classifies Yashtimadhu as a medhya rasayana that can enhance brain function. Neurodegenerative diseases are characterised by gradual loss of neuronal structure and function. It improves memory and has neuroprotective properties that are useful in the fight against neurodegenerative diseases. Rotenone and Yashtimadhu treatments on retinoic acid-differentiated IMR-32 cells allowed for the evaluation of cellular toxicity, live-dead staining, cell cycle, oxidative stress, protein abundance, and kinase phosphorylation. Yashtimadhu prevented the cytotoxicity caused by rotenone, prevented cell death, elevated anti-apoptotic protein expression, and decreased pro-apoptotic protein expression.[16]. A recent study shows that 150 mg/kg of liquorice extract (equivalent to 5.19 g of dried plant material) administered orally for seven days improved learning and memory of mice significantly in both the exteroceptive behavioural models employed. The stimulus lies outside the body in exteroceptive behaviour models, whereas it lies within the body in the case of interoceptive models. This is the first research finding showing enhanced learning and memory by liquorice[17].

Jyotishmati *(Celastrus paniculatus)*

Jyotishmati is a perennial, prostate or sub erect spreading hairy herb[18]. The recommended therapeutic form is a fine paste of the whole plant. They are highly regarded as medhya (intellect promoters)[19]. Important chemical principles are microphyllic acid, shankhapushpin, kaempferol-kaempferol-3-glucoside, 3, 4 dihydroxycinnamic acid, and sitosterols. Neuroprotective and

intellect-promoting activity implicated in free radical scavenging and antioxidant properties.[20] Chittodvega (anxiety disorders) signs and symptoms can be effectively treated with Shankhapushpi.[21] According to herbalists, Shankhpushpi soothes nerves by controlling the body's synthesis of the stress chemicals cortisol and adrenaline.[22].

Guduchi *(Tinospora cordifolia)*

Guduchi, also known as *Tinospora cordifolia* (Wild) Miers, is a large, glabrous, deciduous climbing shrub native to tropical India[23]. The therapeutic use of whole-plant juice is known as medhya [24]. Additionally, it is utilised as a powder, decoction, and satwa (a stem starch extract). Alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoids, phenolic, aliphatic chemicals, and polysaccharides are among the chemical components[25]. Their antioxidant and trace element levels give them their neuroprotective and ameliorative abilities[26]. Zinc and copper, which function as antioxidants and shield cells from the harmful effects of oxygen radicals produced during immunological activation, are abundant in the plant species *Tinospora cordifolia*[27]. There have been claims that *Tinospora cordifolia* can improve memory and learning[28]. In a behavioural test, *Tinospora cordifolia* improved cognition in healthy animals with cognition deficiencies: the passive avoidance task and the Hebb William maze [29]. Choline supplementation improves understanding through an immunostimulant-mediated mechanism that also increases acetylcholine production[30].

Kushmanda *(Benincasa hispida)*

Kushmanda has been repeatedly mentioned and appreciated for its 'Chetovikaranasanam' (psychological disorder) due to its medhya (nootropic) effect. Kushmand (*Benincasa hispida*), belonging to the family Cucurbitaceae, is a medicinal as well as nutritional herb having properties like madhura rasa, laghu, snighdha guna, madhur vipaka *and* sheeta virya. The chemical constituents of *Benincasa hispida* fruits have volatile oils, flavonoids, glycosides, saccharides, carotenes, vitamins, minerals, ß-sitosterol and uronic acid. This drug has been proven for multiple pharmacological activities such as antioxidant, anxiolytic, anti-compulsive, anticonvulsant, antidepressant, significant action on Alzheimer's disease, etc. The present review draws attention towards the neuro-nutrient impact of Kushmanda in medhakshya and its related chetoroga (psychiatric disorders)[31].

Vacha *(Acorus calamus)*

Vacha is one of the most renowned herbs of the ancient Vedic seer as a rejuvenate for the brain and nervous system[32]. Vacha stimulates the power of self-expression and intelligence. A study of the *Acorus calamus* was done to induce neurotoxicity against acrylamide to increase the activity of the corpus striatum while dopamine receptors decreased. These neurobehavioral changes are occurring by ACR (acrylamide) for treating diseases with the *Acorus calamus* rhizome. The effect of *Acrous calamus* leaf extract was studied on the dopaminergic system in mice for neuromodulator effect. The results of methanol and acetone extract of the plant leaves against the apomorphine (APM) induced stereotypy and haloperidol-induced catalepsy were found. The administration of ACME and ACAE (*Acorus calamus* methanol extract and *Acorus calamus* acetone extract) potentiated the haloperidol-induced catalepsy in mice. It was also found that the ACME and ACAE treatment at various levels against the APM-induced catalepsy in mice significantly reversed the stereotypy[33].

Compound Preparations

Saraswatharishta

Saraswatarishta is a well-known Ayurvedic formulation often prescribed to control neurological illnesses and disorders such as slurred speech, anxiety, Parkinson's disease (PD) and Alzheimer's disease (AD). However, scientific research on its mode of action has not been studied extensively. Therefore, this study employs network pharmacology to understand better the neuroprotective role of Saraswatarishta (SWRT) in neurological disorders. Out of the 18 ingredients in SWRT, five were considered in this study due to their elevated therapeutic action in neurological disorders. Further, nine active phytoconstituents were chosen from the five selected ingredients. The gene targets of the active phytoconstituents were screened and determined using STITCH, Swiss Target Prediction and ChEMBL. Protein-protein interaction and Gene Ontology (GO) enrichment analysis were carried out using STRING and g: Profiler, respectively. Cytoscape 3.7.2 was used to create three networks: compound-target, the target-disease and the compound-target-disease network. Molinspiration and admetSAR2.0 were used to obtain the bioactivity and blood-brain barrier (BBB) probability scores. The three networks indicated that all nine phytoconstituents were linked to the gene targets that encode proteins involved in the pathways of 10 major neurological disorders. This includes Parkinson's disease (PD), Alzheimer's disease (AD), dementia, Huntington's disease, epilepsy, schizophrenia, spinocerebellar ataxia, amyotrophic lateral sclerosis (ALS), multiple sclerosis and attention deficit hyperactivity disorder (ADHD). The gene targets were expressed significantly in various central nervous system regions such as the cerebral cortex, cerebellum and amygdala. The bioactivity scores of the phytoconstituents were in the active range along with high BBB probability scores, indicating that the phytoconstituents can potentially cross the BBB and impart therapeutic effects[34].

Panchgavya Ghrita

It was observed that Panchagavya ghrita is effective in cognition in Autism. Panchgavya is a bioproduct used long back for spiritual and treatment purposes. Based on the action of doshas, the drug is Kapha Vata shaman in nature, with much more Kaphahartava than Vatahartava. It also cleans the channels in the body, bringing clarity to the mind and its functions. Besides that, ghrita is the best drug for potentiating dhee, dhrati and smriti, which is the component of buddhi as per Ayurveda[35].

Brahmi Ghrita

Brahmi, a medhya drug, is recommended for various psychosomatic and psychiatric disorders. Most of the formulations acting on the psyche are ghee-based. It is well established that the drugs to have action on the brain should have the capacity to cross the blood–brain barrier, and for that purpose, ghee is the best drug vehicle[36]. Brahmi ghrita is a polyherbal ayurvedic formulation that is widely used in the management of psychiatric disorders. In significant Ayurvedic literature, there are dissimilarities in its preparation and its indications. According to Charaka Samhita, it is mainly indicated for Unmada, Alakshmi, Apasmara and Papjanya vikaras (diseases due to sinful acts). As per Sushruta Samhita, it is mentioned for Kustha, Vishama Jwara, Apasmara, Unmada, Visha, and Bhutagrahavesha, and according to Ashtanga Hridaya it is recommended for Unmada, Kustha, Apasmara, infertility, for enhancement of speech and memory[5].

Mahapaishachika Ghrita

The main ingredients of Mahapaishachika ghrita *are;* Jatamansi *(Nardostachys jatamansi),* Haritaki *(Terminalia chebula),* Bhutakeshi *(Vitex negundo),* Carati *(Kumbhi) (Careya arborea),* Markati *(Mucuna pruriens),* Vacha *(Acorus calamus),* Trayamana *(Gentiana kurroo),* Jaya (Jayanti) *(Sesbania aegyptiaca),* Veera-Ksheera Kakoli *(Lilium polyphyllum),* Choraka *(Angelica glauca), Katuka Rohini (Picrorrhiza kurrao),* Kayastha *(Elettaria cardamomum),* Varahikanda *(Dioscorea bulbifera),* Chatra (*Foeniculum vulgare),* Atichatra *(Peucedanum graveolens),* Palankasha *(Commiphora mukul),* Mahapurusha Danta *(Asparagus racemosus),* Vayastha *(Bacopa monnieri),* Gandha Nakuli *(Aristolochia indica),* Rasna *(Pluchea lanceolata),* Katabhi *(Celastrus paniculatus),* Vrischikali *(Pergularia extensa),* Shalaparni *(Desmodium gangeticum),* go-ghrita*,* Most of the drug in Mahapaishachika ghrita are tikta (bitter), katurasa (pungent), ushna veerya (hot in potency, Vatakaphaharam and pramadhi (channel-clearing) in nature[37].

Panchkarma Therapies for management of ASD

Abhyanga

Abhyanga is a process by which the body surface, i.e., the integument, undergoes manual pressure by various techniques and various substances to provide not only relaxation of the body but also the pacification of several types of disease[38]. Through which Abhyanga may act on different body systems, the skin is the body's gateway. The skin's surface is divided into innumerable lymph chambers with diameters of 8-12 mm each, so during the act of Abhyanga, a massage of the lymphatics could be performed by which lymph flow, as well as lymph movement, is possible[38]. Lymphs contain large amounts of tryptophan and albumin. It is recorded that the number of amino acids like tryptophan moderately increases in blood after performing a lymphatic massage. The increased level of tryptophan in plasma may cause an increase in the level of several neurotransmitters and serotonin that help an individual fight against anxiety, depression, schizophrenia and many more.

On the other hand, a study with radioactive tryptophan shows its accumulation in the pineal gland, which suggests that the pineal gland uses tryptophan to secret melatonin and serotonin, which helps to maintain the equilibrium of thyroidal, gonadal and adrenal activity as well as secretion of growth hormone. A deficiency of serotonin is responsible for irritability, depression, schizophrenia, florid hallucination, paranoia, severe headache, anxiety, etc.[40] Melatonin decreases protein synthesis in the hypothalamus and pituitary, resulting in a decrease of the concerned hormones[40]. The pineal gland has a diurnal rhythm, and because it is sensitive to light, it produces a high level of serotonin during the daytime and a high level of melatonin during nighttime. Thus, serotonin and melatonin maintain equilibrium in the normal condition. So Abhyanga, i.e., the manual drainage of lymph may play a significant role in deficiency of any of these two, and clinically it is established. Melatonin is also responsible for sedation and pleasant feelings in human being[38].

Shiro Pichu (Application of oil overhead)

It is a specialised Ayurveda therapy in which a piece of cloth or cotton soaked with medicated oil is applied overhead for 60 minutes or more uniquely. A fabric or cotton folded to palm size is drenched in warm herbal oil. It is then kept on the patient's crown. Warm oil is poured Shiropichu is used in the management of psychosis, facial palsy, headache, insomnia, memory loss, dermatitis of the scalp, dandruff and other neurological disorders. It relaxes the brain and improves memory concentration. Shiropichu is a vital treatment measure in Autism Spectrum Disorders. It is generally considered that the medicated oils applied overhead at the anterior fontanel region may be diffused intra-dermally into the ventricles of the brain and brain tissues via the superior sagittal sinus. It is more effective in Vata, the dominant type of Autism Spectrum Disorder. Vatasani tailam, Tunga drumadi tailam, Chandanadi tailam, Himasagra tailam are some of the oils found effective in managing Autistic children. Specific Ghee preparations are also used for Shiropichu's purpose in managing Autism Spectrum Disorders[39].

Shirodhara (Pouring of liquid medication over the forehead)

It is a procedure-based therapy that involves gently pouring liquid medication over the forehead. The name comes from the Sanskrit words shiro (head) and dhara (flow). The liquid used in Shirodhara depends on what is being treated but can include oil, milk, buttermilk, coconut water, or even plain water.

Shirodhara has been used to treat various conditions, including eye disease, sinusitis, allergic rhinitis, greying of hair, neurological disorders, memory loss, insomnia, hearing impairment, vertigo, Meniere's disease and certain types of skin diseases.

Shirodhara is preferred to manage older children with Autism Spectrum Disorders. Even though Shirodhara is safe, infants and younger children often do not cooperate to carry out this procedure.

It may be better to try Shiropichu first in younger age groups and Shirodhara later whenever the child cooperates with the treatment procedure. The oils mentioned for Shiropichu are used for doing Shirodhara. In Pitta dominant Autism Spectrum Disorders, Shirodhara with buttermilk is a better choice[39].

Basti (Enema)

Basti is the specialised panchakarma procedure to cure Vata-dominant disorders. It is used to promote the elimination of the vitiated Vata dosha (specific toxic metabolites) out through the rectum. In this panchakarma procedure, medicated oil, decoction, and certain other medication are administered through the anus to pacify the aggravated Vata dosha. Usually, Basti has two types- Nirooha basti (decoction enema), in which herbal decoction is used and Anuvasan basti (oil enema), in which herbal oil is used primarily in the form of enema.

Basti, or medicated enema, helps manage Autism Spectrum Disorders. It is beneficial in Vata's dominant variety of Autism. Enema prepared with Ayurvedic decoction (kashaya basti) will extract the accumulated metabolic wastes in Autistic children. Enema with medicated oil (sneha basti and matra basti) shall alleviate many of the communication and sensory integration problems of Autism[39].

Nasya (Nasal draining)

Nasya is a panchakarma therapy that uses medicated liquids, oils, powders, etc., through the nose. It is meant to purify the head from vitiated doshas (toxins accumulated in the sinus, nose or head are eliminated). It keeps the eyes, nose and ears healthy if done regularly.

Nasya is a beneficial therapy for Autism Spectrum Disorders. Since the brain is the most affected area in Autism Spectrum Disorders, Nasya is the shortest and most effective route to expel

the biological wastes accumulated in the brain. Different oils, liquid extracts, medicated powders, etc., are used for doing Nasya[39].

CONCLUSION

ASD is a neurodevelopmental disorder. Its prevalence rate has dramatically increased. Autism spectrum disorder varies widely in symptoms and severity, making diagnosing difficult. There is no cure for autism spectrum disorder in modern science. The goal of treatment is to maximise your child's ability to function by reducing clinical features of ASD and supporting development and learning. In this way, Ayurveda provides a cheaper, untoward, effect-free treatment of Autism Spectrum Disorders via maintaining homeostasis in Doshas at physical and mental levels. Thus, Ayurveda plays a crucial role not only in its management and improvement in quality of life but also in prevention.

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