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Review article

Anti-paralytic medicinal plants – Review

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ABSTRACT

Paralysis is the loss of the ability of one or more muscles to move, due to disruption of signaling between the nervous system and muscles. The most common causes of paralysis are stroke, head injury, spinal cord injury (SCI) and multiple sclerosis. The search for cure of paralysis is yet to be found. Many ethnobotanical surveys have reported the use of medicinal plants by various ethnic communities in treating and curing paralysis. The present review discusses the use of medicinal plants in India for ameliorating and curing paralytic conditions, as well as discuses some of the important developments in future possible applications of medicinal plants in treatment of paralysis. This review reports the use of 37 medicinal plants for their application and cure of ailments related to paralysis. Out of the 37 plants documented, 11 plants have been reported for their ability to cure paralysis. However, the information on the documented plants were mostly found to be inadequate, requiring proper authentication with respect to their specificity, dosage, contradictions etc. It is found that despite the claims presented in many ethnobotanical surveys, the laboratory analysis of these plants remain untouched. It is believed that with deeper intervention on analysis of bioactive compounds present in these plants used by ethic traditional healers for paralysis, many potential therapeutic compounds can be isolated for this particular ailment in the near future.

1. Introduction

Paralysis is a disease related to nervous disorder caused by damage of nerves and spinal cord that control muscles. The most common causes of paralysis are stroke, head injury, spinal cord injury, broken neck and multiple sclerosis.[1] Other causes of paralysis include nerve diseases such as amyotrophic lateral sclerosis, autoimmune diseases such as Guillain-Barre syndrome, Bell's palsy, which affects muscles in the face, and Polio virus.[2] Paralysis can be of localized form, where a specific section of the body is paralyzed, such as the facial paralysis (Bell's Palsy) and paralysis of hand, or generalized form where a larger area of the body is affected, such as the condition where one limb is paralyzed or where the arm and leg on one side of the body are paralyzed. Therefore, depending on the condition and body part(s) affected by paralysis, a number of medical terms are used to describe different types of paralysis. Examples are namely, monoplegia – where one limb is paralyzed, hemiplegia – where the arm and leg on one side of the body are paralyzed, paraplegia – where both legs and sometimes the pelvis and some of the lower body are paralyzed, tetraplegia – where both the arms and legs are paralyzed (also known as quadriplegia). Paralysis when left untreated for a long period could lead to the 'death' of the affected part i.e. wasting of muscles and tissues. Paralysis can also cause a number of associated secondary conditions, such as urinary incontinence (an inability to control the flow of urine) and bowel incontinence (where stools leak from the back passage). It may also affect sexual function in both men and women. In cases of permanent paralysis, treatment aims mostly at assisting a person live as independently as possible by addressing any associated complications that arise from paralysis, such as pressure ulcers (sores that develop when the affected area of tissue is placed under too much pressure), bladder and bowel problems, and treating spasms and complications resulting from paralysis. Mobility aids such as wheelchairs and orthoses can help a person with paralysis.[1] However, all these forms of treatment mostly

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focused on assisting patients to attain a little degree of controlling their movement, as there is currently no cure for paralysis.

2. Alternative medicines used in paralysis

Across the globe, traditional medicines in the form of crude herbal extracts of single plant or combination of plants, with or without additional minerals have been used in alleviating and curing diseases related to problems of nervous system, some of which includes *Calotropis procera, Satureja thymbra, Coridothymus capitatus, Thunbergia laurifolia, Annona reticulate, Annona squamosa, Plumeria rubra, Crateva magna, Crateva religiosa, Argyreia osyrensis, Suregada multiflora, Cassytha filiformis, Oxyceros horrid, Citrus aurantifolia, Citrus medica, Cissus hastate, Cissus repens, Aloe vera, Ricinus communis, Tamarindus indica, Alocasia macrorrhizos, Murraya koenigii*, *Lygodium flexuosum*, *Cassia occidentalis*, *Datura metel*, *Phyllanthus reiculatus, Glycosmis arborea, Aerva persica, C. procera, Hyocyamus niger, Cymbidium aloifolium, Gardenia ternifolia* and *Mikania hirsutissima*.[3–13] In India many plants and plant products are vended in markets that claim for ability to treat paralysis, some of which are Punarnava powder (containing Hogweed or *Boerhavia diffusa*), Ashwagandha powder (containing *Withania somnifera*).[14,15] The poly herbal drug Majoon-e-Azaraqi is an ancient herbal Unani compound formulation which is therapeutically use in nerve strengthening, hemiplegia, facial paralysis, tremor, trembling, rheumatism, epilepsy and neurasthenia. Majoon-e-Azaraqi is constituted of 15 ingredients (*Strychnos nuxvomica, Borago officinalis, Lavandula stoechas, Cochlospermum religiosum, Cocos nucifera, Pinus gerardiana, Eletarria cardamomum, Curcuma zeodaria, Pastinaca secacul, Santalum album, Emblica officinalis, Terminalia chebula, Aquilaria agallocha, Syzygium aromaticum* and Sugar).[16] In homoepathic approach, *Rhus toxicodendron* is used in treating paralysis of the lower extremities, treatment of all forms of paralysis which are of a rheumatic origin or brought on by getting wet or exposure to dampness in any form, and in treatment of paralysis due to nervous fevers and typhus. *Aconite napellus* is considered as the sovereign remedy for almost every species of paralysis in homoepathy.[17] *Gelsemium sempervirens* (Gels.) is another plant used in homeopathic for treatment of paralysis.[18] In addition, the homeopathy treatment use *Agaricus muscarius, Cocculus indicus, Solanum dulcamara, Strychnos nux-vomica, Hypericum perforatum and Atropa belladonna*, which are all poisonous sources, in treatment of various paralytic manifestations.[19] The use of *Acanthus ilicifolius, Cedrus deodara and Rubia cordifolia* in paralysis is also reported.[20,21] Apart from these well known reports from different forms of alternative medicines for their application of paralysis, the present review emphasizes on the various ethnobotanical documentation of medicinal plants reported for their use in treatment of ailments related to paralysis in different parts of India. Extensive literature search using Pubmed, Medline, Scopus and Google were conducted in order to extract articles related to ethnobotanical surveys in different parts of India.

3. Anti-paralytic plants from ethnobotanical surveys in India

The extensive literature survey on the use of medicinal plants for paralysis in India showed that relatively few documentation of medicinal plants have been done, and even lesser laboratory authentication and analysis have been done in relation to the applicability in paralysis. Among the total of 29 states and 7 union territories of India, researchers have reported the use medicinal plants for paralysis so far only from 16 states namely Tamil Nadu, Andhra Pradesh, Jammu & Kashmir, Rajasthan, Chhattisgarh, Odisha, Uttar Pradesh, Himachal Pradesh, Uttarakhand, Madhya Pradesh, Manipur, Karnataka, Assam, Maharashtra, West Bengal and Telangana, from where a total of 37 plants, belonging to 25 plant families (Table 1) have been reported for their application/cure of ailments related to paralysis.[51–79] Amongst these families, plants belonging to Asteraceae represented the highest, followed by Fabaceae and Mimosaceae. Lesser number of plants from the family Euphorbiaceae, Lamiaceae, Liliaceae, Rubiaceae and Ranunculaceae are represented for their use in this regard. Members of plants belonging to Acanthaceae, Asclepiadaceae, Araliaceae, Bombacacea, Caesalpinaceae, Cannabinaceae, Celastraceae, Marsiliaceae, Meliaceae, Malvaceae, Menispermaceae, Moraceae, Oleaceae, Orchidaceae, Rutaceae, Vitaceae and Urticaceae represented the least for their used in paralysis (Fig. 1). Nine different plant parts were found to be used for various treatment of the ailment. In most of the cases, the leaves are mostly used, followed by roots, seeds, whole plants, stem, barks, fruit, flower head and bulb respectively (Fig. 2). Amongst the 37 plants reported, 11 plants are reported for their ability to cure paralysis (Table 2). However, in most of the ethnobotanical studies, the information mentioned and documented are inadequate, wherein the use of the plant, the mode of use, the methods of preparation, dosage, durations, specificity, effectiveness and contradictions are not discussed in details. In addition the type of paralysis (whether localized or general paralysis, monoplegia, hemiplegia, paraplegia or tetraplegia) for which the plants is used is mentioned only in 6 plants (Table 3). The remaining 26 plants are reported for their use in paralysis without specifying any details about their ability to cure, as well as the types of paralysis for which they are used for. No doubt, there information are undeniably useful, as ethnobotanical survey data and traditional knowledge of medicinal plants are one of the irreplaceable pools of knowledge, in which unplumbed information are stored. It is believe that with deeper research into the bioactive composition and mode of actions of the chemical contents of these documented medicinal plants, a goal for finding important lead compounds for treatment of ailments and complications associated with neural disorders leading to paralysis, can indeed be achieved in the future.

4. Laboratory studies on plants used in paralysis

In the last decades few laboratory studies have been conducted to understand the efficacy of medicinal plants for their application in ailments related to nerve injury or functions. Maryam Tehranipour and Tooba Ghadamyari reported that alcoholic root extract of *Salvia staminea* could increase neuronal density of motoneurons in anterior horn of spinal cord following sciatic nerve compression.[80] Spinal cord ischemia/reperfusion (I/R) injury may lead to immediate or delayed paraplegia in 4%–33% of patients undergoing surgery on the thoracic aorta.[81] Therefore, in an attempt to prevent any undesired complications, various methods of spinal cord protection have been suggested, including temporary shunts or partial bypass, hypothermia, drainage of cerebrospinal fluid, and pharmacologic measures.[82–84] Despite the use of these methods, paraplegia remains a persistent complication.[85] Tetramethylpyrazine (TMP), also called ligustrazine, is an alkaloid extracted from the Chinese herbal medicine, *Ligusticum wallichii* (chuanxiong).[86] For hundreds of years, TMP has been routinely used for the treatment of heart, kidney, and brain diseases.[33,87,88] Spinal cord I/R induce significant increase in the concentration of malondialdehyde (MDA) in the spinal cord, indicating lipid peroxidation.[89] Studies showed that TMP treatment reverse the increase in MDA levels to a considerable extent, and ameliorated the down regulation of spinal cord superoxide dismutase (SOD) activity, thereby confirming the antioxidant role of TMP in I/R.[22] In animals that had significant impairment of motor function, evidence of both necrosis and apoptosis was apparent. The Bcl-2 proteins comprise both anti-apoptotic family members, for example, Bcl-2, Bcl-xL, and Mcl-1, and proapoptotic molecules such

Table 1
List plants used in Paralysis.

Sl. no.	Botanical name	Vernacular name/ common name	Family	Part use	Common use	Ref.
1	*Abrus precatorius* Linn.	Rosary Pea	Fabaceae	Seed	Paste of seeds applied externally to treat stiffness of shoulder joint and paralysis in Thanjavur district, Tamil Nadu, India.	22
2	*Acacia mangium* Willd.	Hickory Wattle	Mimosaceae	Bark	Bark is used in paralysis by the tribal communities of Salugu Panchayati of Paderu Mandalam, Visakhapatnam, Andhra Pradesh, India.	23
3	*Actaea spicata* Linn.	Banparthi (H)	Ranunculaceae	Fruit & root	Powder of fruits and roots mixed with water are given to treat paralysis in cattle in some rural areas of Bandipora district of Jammu and Kashmir, India.	24
4	*Adenanthera pavonina* Linn.	Bead Tree	Mimosaceae	Seed	Used for the treatment of paralysis.	25
5	*Allium sativum* Linn.	Garlic	Lilliceae	Bulb	Bulbs are used in paralysis in Shekhawati region, Rajasthan, India	26
6	*Anacyclus pyrethrum* Linn.	Spanish Chamomile	Asteraceae	Root & whole plant	Roots are used in paralysis by Malayali tribals in Kolli hills of Eastern ghats, Tamilnadu, India. The paste of the whole plants mixed with mustard oil is also used as remedy for paralysis.	27,28
7	*Anthocephalus indicus* Rich.	Common Bur-flower	Rubiaceae	Root	Roots are used in paralysis by boiling the grinded root with Mustard oil, and massaged on affected part twice a day for one month by Kamar tribes of Chhattisgarh, India.	29
8	*Asparagus racemosus* Willd.	Satavari	Liliaceae	Root	Root juice mixed with year old Ghee is massaged on whole body to cure paralysis in Kalahandi district of Odisha, India.	30
9	*Atalantia monophylla* Linn.	Indian Atalantia	Rutaceae	Leaf	Essential oil from leaves is used in paralysis.	25
10	*Bombax ceiba* Linn.	Cotton Tree	Bombacaceae	Bark	Bark is molded and fried in *Dissenia pertagyna* oil, and then massaged on affected part to cure paralysis by Rawat and Sahariya tribes of Jhansi district, Uttar Pradesh, India.	31
11	*Cannabis sativa* Linn.	Hemp	Cannabinaceae	Seed	Oil extracted from dry seeds is applied to cure paralysis by tribal communities of Chhota Bhangal, Western Himalaya, India	32
12	*Cassia fistula* Linn.	Golden Shower Tree	Caesalpinaceae	Leaf	Leaves are used in facial paralysis in Bageshwar valley (Kumaun Himalaya) of Uttarakhand, India.	33
13	*Celastrus paniculata* Willd.	Black Oil Plant	Celastraceae	Seed	Seeds are used in paralysis.	34
14	*Centipeda minima* Linn.	Spreading Sneeze Weed	Asteraceae	Seed	Seed paste is applied externally to get relief from arthralgia and paralysis by Theoraon tribe of Jashpur District, India.	35
15	*Cissampelos pareira* Linn.	Velvet Leaf	Menispermaceae	Root	Roots are used in paralysis by boiling the grinded root with Mustard oil, and massaged on affected part twice a day for one month, by Birhor tribes of Chhattisgarh, India.	36
16	*Cissus quadrangularis* Linn.	Veldt Grape	Vitaceae	Stem	Spoonful of stem paste is taken orally for 20–30 days for the treatment of paralysis in Godavari district of Andhra Pradesh, India.	37
17	*Cryptolepis buchanani* Roem. & Schult.	Wax Leaved Climber	Asclepiadaceae	Stem	A decoction of the stem is used as a supporting drug in paralysis.	25
18	*Cymbidium aloifolium* Linn.	Aloe-leafed Cymbidium	Orchidaceae	Root	2 g of root powder mixed with 2 g dried ginger and 1 g of black pepper, half spoon of which is taken with a cup of milk twice a day for two months to reduce paralysis.	38
19	*Entada pursaetha* DC.	Giant's Rattle	Mimosaceae	Seed	Gond, Halba and Maria tribes of Abujmarh area in Madhya Pradesh use the paste of the seeds for curing paralysis.	39
20	*Gendarussa vulgaris* Nees.	Willow-leaved Justicia	Acanthaceae	Leaf	Infusions of leaves are taken orally in cephalalgia, hemiplegia and facial paralysis.	25
21	*Ficus religiosa* Linn.	Sacred Fig	Moraceae	Bark	Bark powder is used in paralysis in Bageshwar valley (Kumaun Himalaya) of Uttarakhand, India. Root/stem bark extract mixed with buttermilk is taken 2 tea spoonfuls twice a day for 30 days for paralysis.	33,40
22	*Jasminum grandiflorum* Linn.	Royal Jasmine	Oleaceae	Whole plant	Whole plant extract is used externally to treat facial paralysis in Thanjavur District, Tamil Nadu, India.	22
23	*Jatropha curcas* Linn.	Barbados Nut	Euphorbiaceae	Leaf	It is used for curing paralysis in Bodamalai hills eastern Ghats, Namakkal district, Tamil Nadu. Latex is applied externally in paralysis in Sirumalai hills of eastern Ghats, Dindigul District, Tamil Nadu, India.	41,42
24	*Jatropha gossypifolia* Linn.	Bellyache Bush	Euphorbiaceae	Fruit	It is used to cure paralysis in Bodamalai hills eastern Ghats, Namakkal district, Tamil Nadu and in Pudhukkottai district, Tamil Nadu, India.	41,43
25	*Marsilea minuta* Linn.	Dwarf water clover	Marsileaceae	Whole plant	Whole plant is used in paralysis by the tribes in the hills of Manipur, India.	44
26	*Melia azedarach* Linn.	White Cedar	Meliaceae	Leaf	Rawat and Sahariya tribes of Jhansi district, Uttar Pradesh boil about 500 g of the leaves in 5–6 L of water till the color change. Then the patient is bath in this water for 8–10 days to cure paralysis.	31
27	*Mentha arvensis* Linn.	Peppermint	Lamiaceae	Leaf	Leaves of *M. arvensis* and seeds of *Trachyspermum ammi* are taken in equal proportions along with rock salt, and this are taken with coffee, three to four times a day in paralysis by local communities in some villages of Shimoga District, Karnataka, India.	45
28	*Mucuna pruriens* Linn.	Velvet Bean	Fabaceae	Root		46

Table 1 (*continued*)

Sl. no.	Botanical name	Vernacular name/ common name	Family	Part use	Common use	Ref.
					Roots are used in paralysis by tribes of district Shahdol, Madhya Pradesh, India.	
29	*Naravelia zeylanica* (Linn.) DC.	Vatanasini (H)	Ranunculaceae	Leaf	Leaf juice is used for paralysis by applying externally by the Malayali tribals in Kolli hills of eastern Ghats, Tamilnadu, India.	27
30	*Ocimum gratissimum* Linn.	Clove Basil	Lamiaceae	Leaf	Leaves are used for paralysis by the local fringe communities of Chirang Reserve Forest, Assam, India.	47
31	*Paederia foetida* Linn.	Stinkvine	Rubiaceae	Leaf	Leaves are used in paralysis by tribes in the hills of Manipur, India.	44
32	Pongamia pinnata (Linn.) Merr.	Indian Beech	Fabaceae	Leaf & Stem	Leaves are used in paralysis by tribals of Khammam district, Telangana state, India. Extracts of bark boiled with Sesame oil is massaged on skin to cure paralyzed organ (leg/hand), by the Ethnic People of Kalahandi district, Odisha, India.	30,48
33	*Schefflera venulosa* (Wight & Arn.) Harms.	Dain (H)	Araliaceae	Leaf	Leaves are used in paralysis by the tribes in the hills of Manipur, India.	44
34	*Sida cordata* (Burm.f.) Borss.Waalk.	Country Mallow	Malvaceae	Leaf	Leaf juice mixed with goat's milk is used for curing paralysis in Nallamala, Andhra Pradesh, India.	40
35	*Spilanthes acmella* Linn.	Toothache Plant	Asteraceae	Stem	The Birhor tribes and Kamar tribes of Chhattisgarh mix stem powder with oil of *Madhuca indica* and massaged twice a day for 20 days to cure paralysis.	29,36
36	*Spilanthes paniculata* Wall. ex DC.	Spot Flower	Asteraceae	Root & flower head	Used for paralysis of tongue in Beed district of Mahrashtra, India.	49
37	*Urtica dioica* Linn.	Common Nettle	Urticaceae	Whole plant	The whole herb is crushed and the extract as well as the paste is used to cure paralyzed limbs in district Ganderbal, Jammu and Kashmir, India.	50

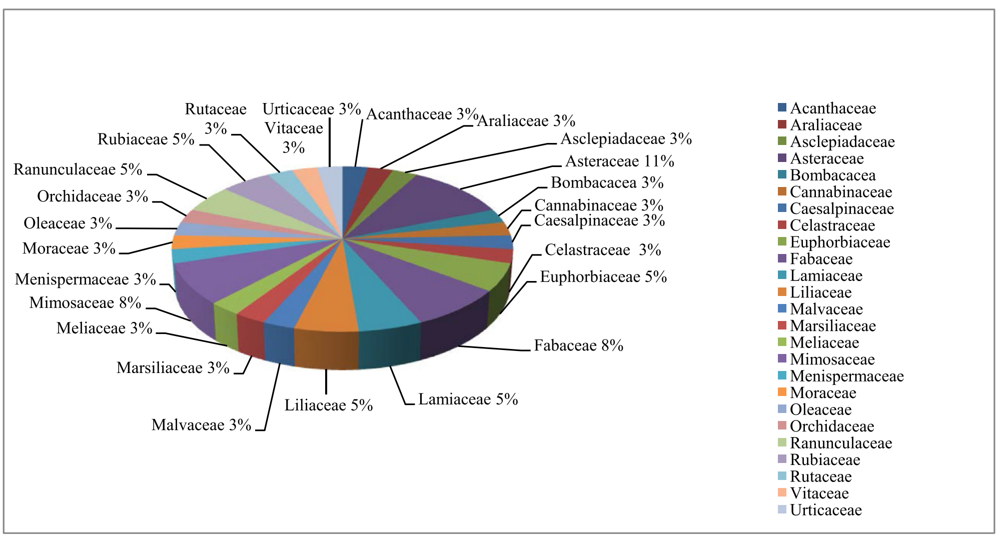

Fig. 1. Distribution of anti-paralytic plants in different plant families.

as Bax, Bak, and BH3 domain only molecules. The ratio of anti- to proapoptotic molecules such as Bcl-2/Bax determines the response to a death signal.[23] In addition, over-expression of Bcl-2 may play a protective role in neuropathological sequelae after central nervous system (CNS) insults.[24] It was shown that treatment with TMP up-regulated the level of the anti-apoptotic protein Bcl-2 and down-regulated pro-apoptotic protein Bax, suggesting that TMP exhibit an inhibitory effect on apoptotic cell death due to spinal cord I/R through modulation of Bcl-2 family. Thus, TMP treatment could increase the proportion of animals with normal motor function, and in these animals, necrosis was decreased and more normal moto-neurons were preserved.[22]

Acute spinal cord injury (SCI) caused by motor vehicle accidents, sports injuries, diving accidents and violence, is one of the most common and devastating injuries encountered at the spine surgery department. SCI injury has a high rate of prevalence in the younger population, and causes permanent disability or lost of movement and sensation.[25,26] Many studies have shown that injury induced inflammation can result in neuropathology and secondary necrosis after traumatic SCI.[27–29] Inflammation plays an important role in the progressive secondary injury that causes neurological deficits.[30] Some studies have shown that the treatment between the primary and the secondary injury of SCI has the potential to either prevent or reduce the final neurological deficits.[31,32] TMP have been shown to have the ability to reduce cerebral ischemia/reperfusion injury through suppression of inflammatory cell activation and proinflammatory cytokine production,[33,35] and accelerate spinal cord repair through up-regulating neurofilament protein expression and down-regulating caspase-3 expression following contusion SCI.[36] Traumatic SCI has been reported to activate nuclear factor-kappa B (NF-κB), a transcriptional factor. Hence, knockdown of NF-κB *in vivo* could have the ability to improve function recovery after SCI.[27,37] In normal conditions, the NF-κB is combined with inhibitor of kappa-Bα (I-kBα) in the cytoplasm, and does not have

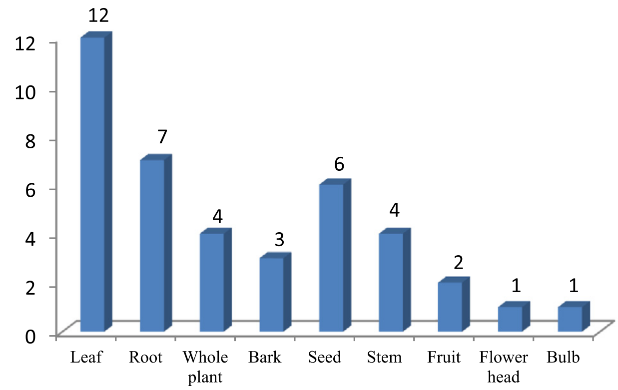

Fig. 2. The use of different plant plants for paralysis. Leaves showed highest application, followed by roots and seeds. Flower head and bulb showed the least application in terms of number.

Table 2
Plants documented for their ability to cure paralysis.

Sl. no.	Botanical name	Type of paralysis cured
8	*Asparagus racemosus* Willd.	Not specified
10	*Bombax ceiba* Linn.	Not specified
11	*Cannabis sativa* Linn.	Not specified
19	*Entada pursaetha* DC.	Not specified
23	*Jatropha curcas* Linn.	Not specified
24	*Jatropha gossypifolia* Linn.	Not specified
26	*Melia azedarach* Linn.	Not specified
32	*Pongamia pinnata* (Linn.) Merr.	Paralysis of organ (leg/hand)
34	*Sida cordata* (Burm.f.) Borss.Waalk.	Not specified
35	*Spilanthes acmella* Linn.	Not specified
37	*Urtica dioica* Linn.	Paralysis of limbs

transcriptional activity.[38] Another study on TMP reported activation of NF-κB after SCI, which could be inhibited by TMP treatment. However, it was observed that the expression of I-kBα was increased by TMP treatment, suggesting that TMP might have inhibited NF-κB activation through increasing the expression of I-kBα.[39] *Alpinia katsumadai* is a plant used in traditional Chinese medicine. The extract of Alpinia katsumadai seed (EAKS) suppressed topical pruritis, showed anti-inflammatory effects, and enhanced antioxidant activity in several studies.[40,41] It has been reported that repeated oral administration of EAKS protects neurons from ischemic damage in the hippocampus, associated with an upregulation of brain-derived neurotrophic factor (BDNF), a neurotrophic factor in ischemic areas.[42] From these findings with deeper research on bioactive compounds derived from medicinal plants, the cure for paralysis could be achievable in the near future.

5. Current status of drugs used in paralysis

Current major treatment for SCI is the use of high doses of methylprednisolone (MP), which reduces edema of the spinal cord and secondary damages. However, MP has numerous side effects, and its therapeutic effects are controversial. There is insufficient evidence to support the use of MP as a standard treatment for acute SCI.[43] Also treatment using MP is controversially, as prolonged or delayed treatment, incorrect dosing or treatment of penetrating SCI has been shown to be detrimental.[44,45] A recent review on randomized trials examined whether modest improvements have been shown using MP, monosialotetrahexosylganglioside (GM-1) ganglioside, thyrotropin-releasing hormone (TRH), nimopidine and the NMDA (*N*-methyl-D-aspartate) antagonist gacyclidine,[46] where it was concluded that, in most trials, primary outcome measures

Table 3
List of plants for which the type of paralysis treated is mentioned.

Sl. no.	Botanical name	Type of paralysis treated
12	*Cassia fistula* Linn.	Leaves are used in facial paralysis.
20	*Gendarussa vulgaris* Nees.	Leaves are used in cephalalgia, hemiplegia and facial paralysis.
22	*Jasminum grandiflorum* Linn.	Whole plant extract is used to treat facial paralysis.
32	*Pongamia pinnata* (Linn.) Merr.	Bark is used in paralysis of leg/hand.
36	*Spilanthes paniculata* Wall. ex DC.	Root and flower head is used in paralysis of tongue.
37	*Urtica dioica* Linn.	Whole plant is used in paralysis of limbs.

were not significant and placebo controls were lacking.[46] Several studies have also recently reported that intravenous minocycline reduces cell death and improves hindlimb function in mouse and rat models of SCI,[34,48,49] and is expected to progress to clinical trials for SCI.[89] A study on Nebivolol (selective β-adrenergic blocking agent) showed that it prevented the increase in enzymatic activities of superoxide dismutase (SOD), xanthine oxidase (XO), adenosine deaminase (ADA) and myeloperoxidase (MPO) produced by I/R, and also prevented the decrease in spinal cord glutathione peroxidase (GSH-Px) level in I/R, thereby implicating its useful application in preventing secondary injury of nerves.[90] Many people with a spinal cord injury, and some with other types of paralysis, have long-term pain that persists for weeks, months, or sometimes years after the injury or incident that caused the paralysis. Unlike most other types of pain, neuropathic pain does not usually respond well to ordinary painkillers, such as paracetamol or ibuprofen. Alternative medications are usually required, such as amitriptyline or pregabalin. These types of medication can cause a wide range of side effects. Possible side effects include a dry mouth, sweating, drowsiness and vision problems. Reports are also available about people having suicidal thoughts while taking amitriptyline.[91]Thus, there still is urgent need for the development of highly effective and safe neuroprotective therapies for human.

6. Conclusion

The search for paralysis is one of the greatest challenges in medical research. The greatest challenge is to develop means for restoring movement and sensation, and elimination of pain for people with paralysis. Currently, apart from hunting for drugs that can help in restoring paralyzed nerves, various other interventions have been on the limelight with the same goal. Various researchers are also working extensively on the application of electrical stimulation as well as optical and magnetic techniques for activating the neural tissue below the level of injury. Other areas of approach includes surgical interventions, but none of these practices are able to provide total or complete recovery of the injured nerves, and in many cases not very cost effective for common applications. In addition, these approaches and the lacunae associated with them are further complicated by the unavailability of simple protocols, test and assays to experiment them, which also could have accounted for the slow pace in advancement in this field of research. For instance till date there is no simple *in vitro* assay to test the potential applicability of any compounds or drugs against any type of paralysis, since in reports available so far, complicated processes are followed that use rats or mouse for researches related to paralysis. One way of approach could be by devising techniques that can use cultured neuronal cell lines, in which direct assay and experiments could be conducted without the need to use model animal. Such techniques, if developed, would help in simplifying and speeding up the research for understanding of the effects of various compounds, for their potentials to ameliorate or cure paralysis in the future.

Conflict of interest

Nil.

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