degrees of paresis or paralysis. Since the disease is usually contracted at a young age the prolonged paresis or paralysis leads to severe disfigurement of the affected limbs. The paralytic limbs become smaller in comparison to the healthy limb and in many cases also rotated abnormally. The weakened muscular support for the joints leads to uneven loads and unnatural forces acting on the joints and therefore joint degeneration. Many of the patients require the use of braces and artificial supports in an attempt to minimize the effects on the joints. Many of the patients can develop post-polio syndrome. The symptoms include new muscle weakness and extreme fatigue. Since over activity of the motor neurons has been found to be a contributing factor to the development of post-polio syndrome, polio patients are encouraged not to be overly active.

There is a need in the art for devices and methods that can treat such neurological conditions, improve neurological and muscular control and/or improve/reduce the outcomes thereof, in particular, outcomes related to the sensory system, the motor system and/or the movement of subjects afflicted with such conditions.

SUMMARY

According to some examples, the present disclosure provides for methods for treating a subject afflicted with a neurological condition by improving sensory, motor and/or movement parameters of the subject, the methods comprising improving/restoring neurological control and/or neurological function to the subject. In some examples, the subject is afflicted with a neurological condition which is affecting the subjects' gait and the methods of the disclosure can improve the gait parameters of the subject. In some examples, the methods improve and/or restore neuromuscular control to the subject.

In some examples, the methods disclosed herein are based on the unexpected finding that by using the methods and device disclosed herein, various sensory, motoric and/or movement related conditions attributed to the neurological disorders/conditions can be treated, i.e. improved and/or cured. In some examples, the methods disclosed herein are based on the unexpected finding that by using the methods and device disclosed herein, a sensory feedback and improvement in neuro-muscular control is achieved, thereby, various sensory, motoric and/or movement related conditions attributed to the neurological disorders/conditions can be treated. In some examples, sensory feedback and improvement in neuro-muscular control is achieved in a subject in need thereof, by calibrating and adjusting the device disclosed herein, for instance, by adjusting/calibrating it's perturbation. In further examples, by changing the center of pressure (COP) with

which the foot contacts the ground, various sensory, motoric and/or movement related conditions attributed to the neurological disorders/conditions can be treated. i.e. improved and/or cured. In another example, changing the center of pressure (COP) with which the foot contacts the ground is executed through calibrating the device (footwear units) of the disclosure. In another example, COP is changed or altered via a perturbation induced by a protuberance as disclosed herein, wherein the protuberance may be calibrated as further detailed below. In another example, a device of the disclosure alters COP thus changing the movement pattern of a lower limb. In another example, the methods of the disclosure provide a controlled change in movement pattern and concomitantly improve gait parameters and are able to aid in avoiding damage, injury, trauma, or a combination thereof (such as but not limited to: falls, damaging gait, damaging lower limb neuromuscular control or activity) to the subject using the device, thus efficiently enabling the accomplishment of the methods provided herein.

In one example, the present disclosure provides a method of treating a subject afflicted with a neurological condition comprising the steps of: (a) securing a device to a subject's foot, whereby the device comprises a foot securing mean, a support member operably attached to said securing mean, and a moveable/relocatable anterior protuberance and a moveable/relocatable posterior protuberance, wherein the anterior protuberance and the posterior protuberance are ground engaging; (b) calibrating the posterior protuberance and the anterior protuberance to: a balanced position, wherein the balanced position comprises a position whereby the device provides a reduced inversion, a reduced eversion, or both to the subject's foot during the stance phases; and (c) fixing said posterior protuberance and the anterior protuberance to the support member. In some examples, the calibrating may further comprise balancing timing of heel rise.

In another example, the present disclosure provides a method of improving gait in a subject afflicted with a neurological condition, comprising the steps of: (a) securing a device to a subject's foot, whereby the device comprises a foot securing mean, a support member operably attached to said securing mean, and a moveable/relocatable anterior protuberance and a moveable/relocatable posterior protuberance, wherein the anterior protuberance and the posterior protuberance are ground engaging; (b) calibrating the posterior protuberance and the anterior protuberance to: (1) a balanced position, wherein the balanced position comprises a position whereby the device provides a reduced inversion, a reduced eversion, or both to the subject's foot during the stance phases; and

optionally (2) balanced timing of heel rise; and (c) fixing said posterior protuberance and the anterior protuberance to the support member.

In some examples, the present disclosure provides a method of improving/restoring neuro-muscular control and/or neural sensory and motor function of a subject having a neurological disorder, the method comprising the steps of: (a) securing a device to a subject's foot, whereby the device comprises a foot securing mean, a support member operably attached to said securing mean, and a moveable/relocatable anterior protuberance and a moveable/relocatable posterior protuberance, wherein the anterior protuberance and the posterior protuberance are ground engaging; (b) calibrating the posterior protuberance and the anterior protuberance to: (1) a balanced position, wherein the balanced position comprises a position whereby the device provides a reduced inversion, a reduced eversion, or both to the subject's foot during the stance phases; and optionally, (2) balanced timing of heel rise; and (c) fixing said posterior protuberance and the anterior protuberance to the support member.

According to some examples, there is provided a method of treating a subject suffering from neurological disorder comprising the steps of: (a) securing a device to a subject's foot, whereby said device comprises a foot securing mean, a support member operably attached to said securing mean, and a moveable/relocatable anterior protuberance and a moveable/relocatable posterior protuberance, said anterior protuberance and said posterior protuberance are ground engaging; (b)calibrating said posterior protuberance and said anterior protuberance to: a balanced position, said balanced position comprises a position whereby said device provides a reduced inversion, a reduced eversion, or both to said subject's foot during stance phases; and (c) fixing said posterior protuberance and said anterior protuberance to said support member; thereby treating a subject suffering from a neurological disorder; wherein the subject is capable of walking.

In some examples, the calibrating comprises adjusting: (a) a resilience of said anterior protuberance, said posterior protuberance, or a combination thereof; (b) a hardness of said anterior protuberance, said posterior protuberance, or a combination thereof; (c) an elasticity of said anterior protuberance, said posterior protuberance, or a combination thereof; (d) or any combination of (a), (b), and (c). In further examples, calibrating further comprises balancing timing of heel rise. According to additional examples, calibrating comprises adjusting: (a) a height of said anterior protuberance, said posterior

protuberance, or a combination thereof; (b) a convexity of said anterior protuberance, said posterior protuberance, or a combination thereof; (c) a weight of said anterior protuberance, said posterior protuberance, or a combination thereof (d) and a combination of (a), (b), and (c).

According to some examples, the balanced position further comprises a position whereby a reduced valgus, varus, dorsal or plantar torque about the ankle is exerted by said device on said subject's foot.

According to additional examples, the posterior protuberance is a bulbous protuberance, said anterior protuberance is a bulbous protuberance, or both said posterior protuberance and said anterior protuberance are bulbous protuberances.

In further examples, the posterior protuberance and the anterior protuberance are moveably mounted to said support member. In some examples, the posterior protuberance is movable within a calcaneus support portion of said support member. In further examples, the anterior protuberance is movable within phalanges or metatarsals support portion of said support member. In some examples, the anterior protuberance, said posterior protuberance, or their combination comprise a cross-section with a shape of a conic section, said conic section comprising at least one of a circle, ellipse, parabola and hyperbola. In another example, the anterior protuberance is shaped differently from said posterior protuberance.

According to further examples, the neurological disorder is selected from: stroke, cerebrovascular accident (CVA), ischemic CVA, hemorrhagic CVA, Traumatic Brain Injury (TBI), Anoxic Brain Damage (ABD), Cerebral Palsy (CP), Parkinson's disease (PD), Multiple Sclerosis (MS), Spinal Cord Injury (SCI), Charcot-Marry-Tooth (CMT), Guillain–Barré syndrome (GBS) and Poliomyelitis.

In some examples, the improvement in neurological control comprises improvement in gait parameters of the subject. In some examples, the gait parameters are selected from: velocity, step length, single limb support, stability and combinations thereof.

In one aspect, there is provided a footwear comprising a foot securing mean, a support member operably attached to said securing mean, and a anterior protuberance and a posterior protuberance, said anterior protuberance and said posterior protuberance comprise: a convexity A protuberance having a base diameter of 70-100 mm and a height, which is a perpendicular line connecting the highest point and the base, of 10-13 mm, a convexity B protuberance having a base diameter of 70-100 mm and a height, which is a perpendicular line connecting the highest point and the base, of 14-16 mm, a convexity C protuberance having a base diameter of 70-100 mm and a height, which is a perpendicular line connecting the highest point and the base, of 16-18 mm, a convexity D protuberance having a base diameter of 70-100 mm and a height, which is a perpendicular line connecting the highest point and the base, of 19-22 mm, or any combination thereof, said anterior protuberance and said posterior protuberance comprise a ground engaging peak and a base; wherein said base is positioned on a centerline of said support member, wherein said peak is positioned offset from said centerline of said support member, wherein said posterior protuberance and said anterior protuberance are calibrated to a balanced position, said balanced position comprises: calibrating convexity, calibrating height, calibrating weight, calibrating position, calibrating base diameter, or any combination thereof.

In another aspect, there is provided the footwear as described herein, for use in treating a neurological disorder, improving and/or restoring neurological control.

CLAIMS

1. A footwear comprising a foot securing mean, a support member operably attached to said securing mean, and a anterior protuberance and a posterior protuberance, said anterior protuberance and said posterior protuberance comprise: a convexity A protuberance having a base diameter of 70-100 mm and a height, which is a perpendicular line connecting the highest point and the base, of 10-13 mm, a convexity B protuberance having a base diameter of 70-100 mm and a height, which is a perpendicular line connecting the highest point and the base, of 14-16 mm, a convexity C protuberance having a base diameter of 70-100 mm and a height, which is a perpendicular line connecting the highest point and the base, of 16-18 mm, a convexity D protuberance having a base diameter of 70-100 mm and a height, which is a perpendicular line connecting the highest point and the base, of 19-22 mm, or any combination thereof, said anterior protuberance and said posterior protuberance comprise a ground engaging peak and a base; wherein said base is positioned on a centerline of said support member, wherein said peak is positioned offset from said centerline of said support member, wherein said posterior protuberance and said anterior protuberance are calibrated to a balanced position, said balanced position comprises: calibrating convexity, calibrating height, calibrating weight, calibrating position, calibrating base diameter, or any combination thereof.

2. The footwear of claim 1, wherein calibration of said posterior protuberance and said anterior protuberance comprises (a) calibration of resilience of said anterior protuberance, said posterior protuberance, or a combination thereof; (b) calibration of hardness of said anterior protuberance, said posterior protuberance, or a combination thereof; (c) calibration of elasticity of said anterior protuberance, said posterior protuberance, or a combination thereof; or (d) any combination of (a) to (c).

3. The footwear of claim 1, wherein said balanced position further comprises a position in which a reduced valgus, varus, dorsal or plantar torque about the ankle is exerted.

4. The footwear of claim 1, wherein said posterior protuberance is movable within a calcaneus support portion of said support member and said anterior protuberance is movable within phalanges or metatarsals support portion of said support member.

5. The footwear of claim 1, for use in treating a neurological disorder, improving and/or restoring neurological control.

6. The footwear for use of claim 5, wherein said neurological disorder is selected from: stroke,

cerebrovascular accident (CVA), ischemic CVA, hemorrhagic CVA, Traumatic Brain Injury (TBI), Anoxic Brain Damage (ABD), Cerebral Palsy (CP), Parkinson's disease (PD), Multiple Sclerosis (MS), Spinal Cord Injury (SCI), Charcot-Marry-Tooth (CMT), Guillain–Barré syndrome (GBS) and Poliomyelitis.

7. The footwear for use of claim 5, wherein the improving neurological control comprises improving a gait parameter.