

Gait Assistive Integrated Training: Therapeutic program for the development of standing and preparation for walking, for people with motor deficits

Papantonopoulos Konstantinos¹, Vaitsis Nikolaos²

¹ Physiotherapist, Greece

² Medical Doctor, Greece

DOI: <https://doi.org/10.5281/zenodo.17112692>

Published Date: 13-September-2025

Abstract: This paper introduces a foundational concept for an innovative treatment method designed, by physiotherapist Papantonopoulos Konstantinos, specifically for individuals who are in a standing position and preparing to walk, with a particular focus on those who have sustained injuries from accidents. The primary objective of this proposed approach is to facilitate a swift recovery for these individuals following such traumatic events. Research has shown that achieving an upright posture, with minimal reliance on external support, can be advantageous and therapeutically effective, even in situations where there is a considerable loss of sensory and/or motor function. This method aims to improve rehabilitation outcomes by fostering independence and mobility among patients, ultimately enhancing their overall quality of life throughout the recovery journey.

Keywords: gait assistive training, motor deficit.

1. INTRODUCTION

The mechanism and methodology of GAIT (Gait Assistive Integrated Therapy) therapy were established through consistent practice and the necessity for patients to "plant their feet firmly on the ground," thereby loading the lower limbs with the weight of the trunk. In this endeavor, we employ the least amount of external support possible, progressively increasing the challenge, allowing the patient to engage their capabilities and/or learn to harness them. Numerous applications are derived from or influenced by the Proprioceptive Neuromuscular Facilitation (PNF) method, which is extensively utilized in the realm of physical therapy (1). The main feature of the proposed method, conceived by physiotherapist Papantonopoulos Konstantinos, is the adaptation of standing position to produce a "state of readiness" at the patient to act, to increase willingness and voluntary movement, and to facilitate learning through problem-solving procedures. On this State of Readiness, basic PNF principles are applied. The fundamental reference framework is gait analysis. The GAIT methodology aligns with contemporary discoveries in neuroscience, where movement is conceptualized as a holistic process aimed at achieving a clear objective and addressing the challenges posed by gravity. In contrast, traditional methods concentrated on isolated parts or muscle groups, such as preparing the torso prior to standing or reinforcing the knee through quadriceps exercises (2). [Picture 1: Main idea of Gait Assistive Integrated Training]

Main therapeutic directions

The upright posture necessitates that the patient exert effort against gravity, offering somatosensory, vestibular, and visual stimuli that enhance patient engagement. Utilizing a diverse range and intensity of stimuli sustains an adequate level of alertness, thereby assisting the patient in maintaining activity. The GAIT Mechanism is implemented to enable patients to uphold an upright stance for a duration that sufficiently allows them to acquire experience and foster their initiative. In the

standing position, the GAIT Mechanism alleviates 8-10% of the patient's body weight, thereby permitting the loading of the lower limbs. **[Picture 2: Standing is used as a mean of treatment]**

The assistance provided by the mechanism frees the therapist's hands, enabling the implementation of suitable facilitation techniques that are customized to meet the treatment's needs. Structural deficiencies, including a diminished range of motion (ROM) that results in misalignment, are tackled by utilizing the affected limb while standing. The expected increase in sensory stimuli during loading is expected to aid in muscle recruitment and the incorporation of the limb's activity into the patient's overall activity through the process of learning.

The procedure for enhancing range of motion via the GAIT program primarily entails the intentional voluntary movement from a seated to a standing position. Additionally, it facilitates overpressure through a prolonged hold at the extreme range position.

- The patient (Pt) makes an effort towards the specified goal of achieving standing from sitting. Towards this goal s/he uses all the means s/he may have. If need be, the PT may provide support, with the patient still initiating the activity. **[Picture 3: Transition to standing with the use of GAIT Mechanism]**
- The whole trunk moves to the upright position over the stabilized tibias and feet. The UE's pull the trunk anteriorly and then support the upward motion in Closed Kinetic Chain. Hips and knees move in extension.
- The targeted movement of the entire body integrates the activity by both the less and the more affected parts. In cases of hypertonicity, that integration has been shown to have a positive effect on the parts most affected by harmonizing the muscle tone.
- The extension that occurs at the hips and the knees during the transition helps the patient to gain ROM at those parts.
- The loading of the LE's in the supported standing position can (a) release the tension of the soleus and of the Achilles tendon; and (b) improve the ROM at the entire limb.
- Repetition of the voluntary transition to standing improves the elasticity of the fascial system throughout the muscle, tendon, and joint capsule.
- Hands-on mobilization of the joints and the soft tissues can be applied to improve ROM in the supported standing position while the LE's are loaded. **[Picture 4: Gaining range of motion at the lower extremity]**
- The preparation in the sitting position includes the trunk's mobilization:
 - With the Pt sitting on the treatment table's soft yet stable surface, we can work on trunk rotation and anterior lean.
 - With the Pt sitting on a Balance Air Pad, we can improve pelvis anterior and posterior tilt, trunk side bend, and trunk flexion and extension
 - Through use of the Mulligan Concept techniques and by utilizing a mobilization belt, we can focus on thorax mobility in extension, side bend, and rotation.

The correct alignment of the limbs is facilitated by the mechanical pockets of the GAIT Mechanism, aligning with standard sitting and standing positions as well as different stages of the Gait Cycle. Achieving adequate range of motion (ROM) in rigid limbs is frequently the initial therapeutic approach to enhancing sensation and obtaining proprioceptive feedback. Subsequently, the proprioceptive stimuli will be actively augmented to encourage the kinetic response from the muscles in the limb region. The acquisition of ROM should be succeeded by appropriate neuromuscular re-education within the newly attained range. The muscles must be capable of providing support in the limb's new position, particularly in the lower extremities (LEs). Striving to achieve a greater range than what the muscles can manage may result in a reduction of support from the tendinous components of the muscles.

Diminished Motor Control is linked to: Reduced Sensation, Muscle Weakness, Impaired Selective Control (Timing), Fundamental Movement Patterns (such as mass flexion or extension), and Spasticity. The engagement of muscles is crucial for establishing stability and lower extremity utilization while providing trunk support. A decrease in spasticity correlates with an enhancement in muscle strength. The advancement of physiological muscle coordination forms is associated with the functional application of the affected limbs.

The acquisition of motor control through the GAIT Training Program is accomplished by: a) enhancing muscle recruitment, b) diminishing spasticity, and c) alleviating abnormal patterns of muscle coordination. Therapeutic applications, whether used individually or in combination, may encompass:

- Loading the weakened limbs with the weight of the body (Weight Over Weakness) to promote proprioceptive information and motoric response
- Application of PNF principles and techniques such as Approximation, and Resistance.
- Direct tactile stimuli on the dermal surface of those muscles which are in a state of readiness.
- Combination of tactile, visual, acoustic, and vestibular stimuli whose orientation is directed towards functional activities.

Diminished autonomous functioning of the patient undergoing treatment is linked to: a) decreased utilization of the impaired limbs, leading to the Learned Non-Use Phenomenon (3), b) a diminished capacity to formulate suitable strategies for maintaining a position and for transitioning to different positions, c) a reduced capability to acquire new motor skills (impaired Motor Learning ability), and d) a lower level of patient engagement in daily life activities. Gaining autonomous activity through the GAIT Program encompasses:

- Autonomous training exercised by the patient with some help from a caregiver, without the presence of a PT.
- Autonomous use of the GAIT Mechanism when it comes to repeating a part of the treatment, reinforcing initiative, and promoting learning through the trial-and-error process.
- Training with resistance bands in standing.
- Task-specific exercises, such as grasping and transferring objects with the non-affected upper extremity (UE). Such activities help in promoting the loading and the use of the affected LE in standing.
- Interactive training games (e.g., throwing and catching a ball, playing Wii home video games, etc.), with non-specialists.

The seated posture is considered relatively secure and enables patients to enhance the range of motion (ROM) of the trunk, assess their capabilities, and expand their stability thresholds. The therapeutic results achieved in the seated position are subsequently applied to more demanding activities, such as standing and walking. Therefore, while corrections can be made in the seated position, the standing position allows us to provide the patient with increased stimuli for action. The therapeutic results obtained following a series of treatment sessions are referred to as Therapeutic Benefit, a term utilized throughout this work. In each posture, we implement (R | C | A), which stands for:

- Mobilization of the soft tissue in order to obtain the necessary Range (R) of Motion.
- Stimuli which target an increase in muscle recruitment and heighten the perception by the Pt of her/his affected limbs. The goal is to enhance patient ability to have Control (C) over her/his position and movement.
- Activities enhancing patient Autonomy (A). [**Table 1: The development of GAIT Training**]

Treatment evolves through the gradual demand increase in three, different variables:

- Decrease in the base of support and elevation of the center of mass (COM), as is the case with the transition from the sitting to the standing position.
- Increasing the challenge for the Pt in different positions by applying resistance and developing functional activities.
- Decreasing the support provided by the GAIT Mechanism by removing the mechanical pockets and relying on the relative instability provided by the soft floor surface.

As the challenge level during treatment escalates, the patient's response correspondingly intensifies, reaching a point where no further enhancement can be realized. The juncture at which the utmost challenge aligns with the optimal response from the patient is termed as "Optimal" (4). This is due to the fact that an elevated challenge level encourages the patient and offers a range of stimuli that compel the patient to engage. Frequently, patients exhibit improved responses when in a standing position, where the somatosensory and perceptual stimuli are more abundant compared to those experienced in a sitting position, which tends to provide a sense of security. This observation underpins the rationale for the establishment

of the GAIT Program. The Optimal Level of Challenge varies for each patient undergoing treatment. The physical therapist (PT), in collaboration with the patient, must investigate the patient's capacity to elicit the best possible response by experimenting with various positions and activities. Within the GAIT Program, we advocate for standing and striding positions as they afford patients greater stimuli and opportunities to realize their potential.

In the GAIT Program, we facilitate the patient's capacity to acquire new motor skills. To achieve this, we allocate adequate time for the patient to remain in a standing position, encouraging them to cultivate initiative and self-directed actions, solve problems via a trial-and-error approach, and gain insight into their own abilities through the repetition of successful attempts. The verbal feedback we offer should be segmented to align with each specific goal of the treatment.

The basic gait requisites that can be learned by training through the GAIT Program are:

- Transferring the weight over the affected side in standing and striding.
- Maintaining stability at the affected LE during the gait's stance phase.
- Adoption of proper postures for the LE so as to develop the Heel Rocker and Ankle Rocker functions.
- Development of dynamic balance activities for the enhancement of Steady-State, Proactive and Reactive Postural Control.
- Improvement of the ability to produce momentum for the transition to another position (Progression), followed by the production of stability at the required position (Postural Control), and ending with the promotion of Pt ability to adapt to new environmental conditions.

[Picture 5: Weight transfer over the affected part in standing]

[Picture 6: Advanced therapeutic applications in striding]

The patient's capacity to actively manage her/his position, or in other terms, keep the Center of Mass (COM) within the Base of Support (BOS), can be improved through the simultaneous advancement of motor strategies in the subsequent skills:

- Development of Dynamic Stability for the Maintenance of a Position using SteadyState Balance. The development of a person's ability to remain stable in one place includes: a) The alignment and orientation of the different parts of the body (LE to Pelvis | Pelvis to Upper Trunk | Trunk to Head) and b) The Pt's orientation within the space. Development of the Postural Sway Applications serving the development of dynamic stability include:
 - Correction of the limbs' position with the use of the mechanical pockets of the GAIT Mechanism.
 - Tactile stimuli enhancing muscle recruitment in the desired position.
 - PNF applications, such as Approximation and Resistance, to improve Pt stability in the desired position.
- Developing Proactive Postural Control. Developing the Pt's ability to prepare her/his muscle activity in order to face an expected change in the position of the COM, as in the cases of Reaching or Walking, includes: a) Preparatory activity of specific muscle groups in anticipation of movement, b) Broadening the limits of stability, and c) Voluntary weight transfer to different limbs. Applications serving in preparing muscle activity include:
 - Training in functional activities (e.g., Reaching) in the sitting and standing positions.
 - Tactile stimuli applied on the dermal surface of the muscles needed to provide stability (e.g., abdominals in the sitting position; and soleus in the standing one), so as to have the activity already prepared prior to demand.
- Developing Reactive Postural Control. The development of the patient's ability to react and prevent the loss of her/his balance, following an unexpected change in the COM, includes: a) The ability to maintain the COM inside the BOS with In-Place strategies, and b) The ability to create a new BOS with Change-in-Support strategies. The applications that enhance the ability of the patient to react include:
 - Mild tactile disturbances, in different directions and at different speeds, applied mainly in the standing position.
 - A combination of approximation, or tactile stimuli, on parts which need to remain stable (e.g., the pelvis) and mild pushes on distant body parts (e.g., sternum and/or shoulders).

- A combination of tactile stimuli on the affected parts, while the latter are loaded, and development of participation games (e.g., throwing a ball)

The transition from one position to another (e.g., from sitting to standing) can be learned through two, main strategies or a combination of the two:

- A Strategy with Momentum. The patient's capacity to navigate by utilizing momentum encompasses: a) The initiation of movement and the generation of momentum (Progression), b) The establishment of stability in the necessary end-position and the regulation of momentum through Postural Control, and c) The ability to adapt to varying environmental and/or spatial conditions (Adaptation). Therapeutic interventions aimed at the acquisition and regulation of momentum are primarily developed while in a standing position and predominantly involve:
 - A description of the required activity verbally expressed by the therapist to the patient.
 - Training in having the Pt generate momentum through repetitive movement.
 - Application of resistance during the Pt's initial effort against the movement, so that s/he may increase such muscle activity as needed to initiate the mass movement of the trunk and generate momentum.
 - At the end-position, an additional push is applied by the PT, at the direction of the movement, so as to train the Pt to react and control her/his momentum.
 - Modifications in the position the limbs have and, in the support, provided by the GAIT Mechanism so as to train the Pt in adaptability skills.
- A Zero Momentum Strategy. When a patient cannot produce momentum or maintain it in the intended position, a zero-momentum strategy is implemented, which involves progressively loading each limb. The process initiates with the therapist providing support to the patient and proceeds with repeated engagement in the activity. Various forms of movement—passive, assisted, active, and resistive—are utilized across different segments of the range, tailored to the patient's capabilities. The objective of the training task outlined in the preceding two paragraphs is to enable the patient to perform the activity independently.

2. DISCUSSION

The GAIT Therapeutic Program has been designed to provide Treatment in a Standing Position. The primary idea is that standing with minimal external assistance should prepare the limbs for readiness, enabling the physical therapist (PT) to implement a variety of treatment techniques, while allowing the patient (Pt) to realize her/his own potential. The therapeutic activities are focused on: (a) reducing the effects of barriers that hinder function, (b) supplying the sensory and perceptual systems with an adequate amount of information, and (c) fortifying the action systems to generate sufficient movement. The patient's independent repetition of therapeutic activities would further improve the treatment/therapeutic results.

The GAIT Mechanism serves to offer external support at the tibias and heels within a framework of parallel bars. This support restricts the Degrees of Freedom associated with the entire uplift movement, thereby facilitating an easier transition to standing for the patient (Pt). The straightforward framework of reference, coupled with the minimal external support provided, enables the Pt to engage and discover her/his own potentials. Extended and repetitive therapeutic activities performed in a standing position enhance the learning process essential during treatment. By utilizing the GAIT Mechanism, the Pt is able to assume various functional postures, such as standing and striding, as well as navigate different phases of the Gait Cycle. The support offered is minimal, permitting the limbs to bear the weight of the body. Additionally, the proprioceptive input from this loading can be supplemented with tactile, auditory, and visual stimuli.

The configuration of the limbs during loading aligns with crucial stages of the Gait Cycle (5). The enhancement of proprioceptive stimuli through hands-on techniques is grounded in the physiology of the receptors (6). Organizing the therapy is informed by the principles of Motor Control (7). Hands-On methods have been derived from the principles of PNF and Bobath, and further enriched by the methodologies of the Mulligan Concept, Kinesiotape, and Myofascial Release (8). These applications have been adapted to ensure their applicability in both sitting and standing positions. Informed by their own expertise as well as the patient's capabilities and objectives, the physical therapist must choose and tailor the activities they consider most suitable. The GAIT Mechanism can serve as a foundational "platform" for the further development or adjustment of therapeutic applications, enabling their use in minimally supportive standing positions.

The primary objective of the proposed method is to facilitate a swift recovery for individuals following an accident. Achieving an upright position, with minimal external assistance, has been shown to be advantageous and therapeutically effective, even in instances where there is a noticeable reduction in sensory and/or motor function. The design of the mechanism can be adapted, with slight modifications, in nations with varying levels of technological advancement, ranging from Greece and Europe to developing countries. The mechanism operates without the need for sophisticated technology. Instead, it establishes conditions that leverage the body's geometry to assist the individual in standing up. Treatment can be administered in structured rehabilitation facilities, hospitals, or at the patient's home by a qualified therapist. Some therapeutic activities may be carried out independently by the patient or with the help of family members.

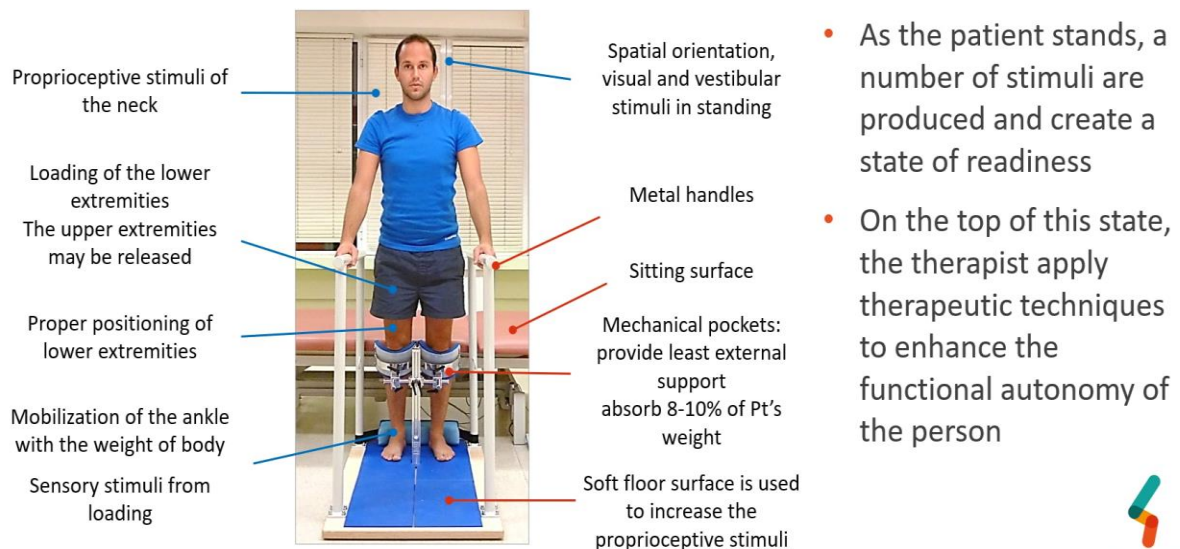
REFERENCES

- [1] Hindle KB, Whitcomb TJ, Briggs WO, Hong J. Proprioceptive Neuromuscular Facilitation (PNF): Its Mechanisms and Effects on Range of Motion and Muscular Function. *J Hum Kinet.* 2012 Apr 3;31:105–13.
- [2] Pathak A, Gyanpuri V, Dev P, Dhiman NR. The Bobath Concept (NDT) as rehabilitation in stroke patients: A systematic review. *J Fam Med Prim Care.* 2021 Nov;10(11):3983–90.
- [3] Taub E, Uswatte G, Pidikiti R. Constraint-Induced Movement Therapy: a new family of techniques with broad application to physical rehabilitation--a clinical review. *J Rehabil Res Dev.* 1999 July;36(3):237–51.
- [4] Shumway-Cook A, Woollacott MH. *Motor Control: Translating Research Into Clinical Practice.* Lippincott Williams & Wilkins; 2007. 634 p.
- [5] Perry J, Burnfield J. *Gait Analysis: Normal and Pathological Function.* 2nd edn. Boca Raton: CRC Press; 2024. 570 p.
- [6] Kandel ER, Schwartz JH, Jessell T. *Principles of Neural Science, Fourth Edition.* McGraw-Hill Companies, Incorporated; 2000. 1434 p.
- [7] Shumway-Cook A, Woollacott MH. *Motor Control: Translating Research Into Clinical Practice.* Wolters Kluwer; 2016. 640 p.
- [8] Mulligan Concept - Manual Therapy [Internet]. [cited 2025 Aug 23]. Mulligan Concept - Manual Therapy. Available from: <https://bmulligan.com/>

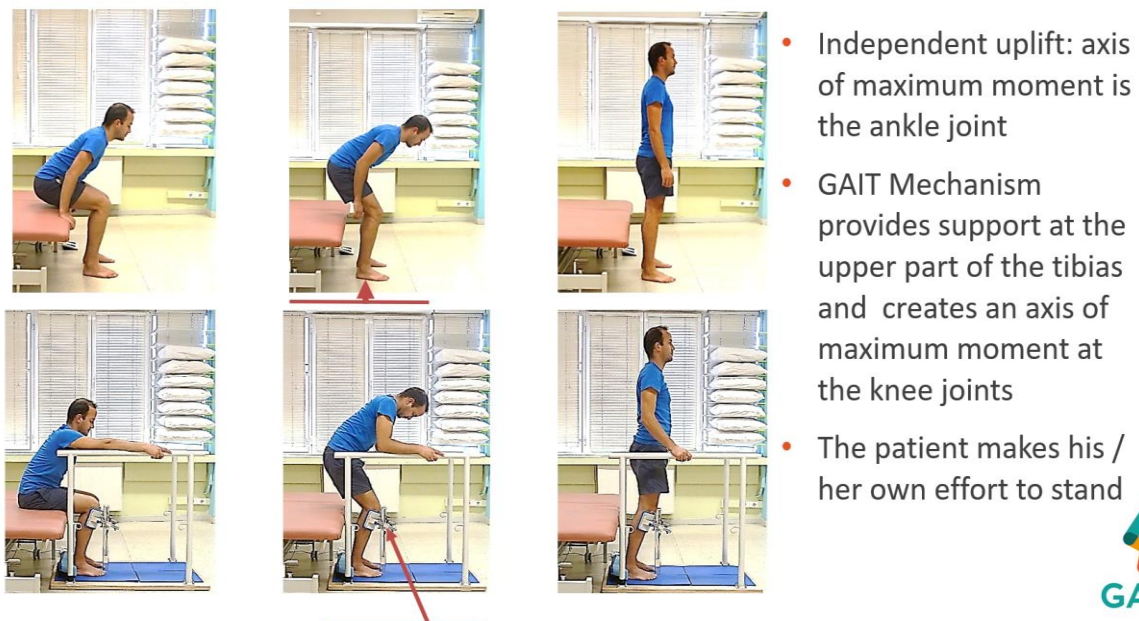
List of Figures & Tables:



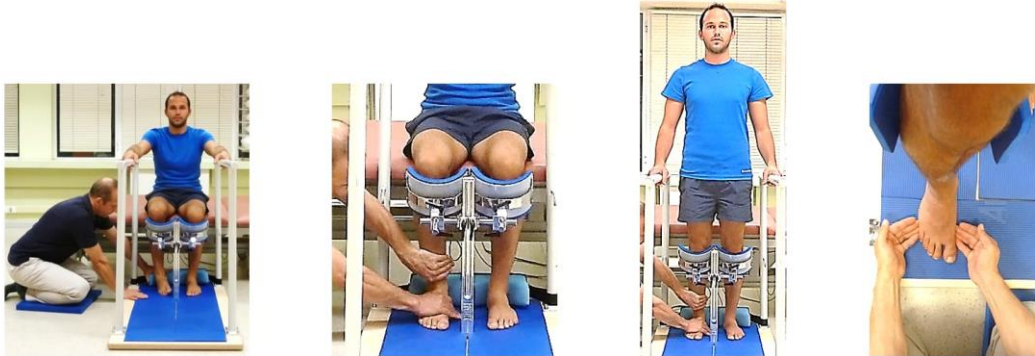
Picture 2: Standing is used as a mean of treatment



Picture 3: Transition to standing with the use of GAIT Mechanism



Picture 4: Gaining range of motion at the lower extremity



1. Initial position of the affected foot
2. Placement of the ankle and foot in proper position to accept weight
3. Voluntary transition in standing and loading of the affected limb
3. After gaining ROM, the therapist may place a demand for activity



Picture 5: Weight transfer over the affected part in standing



1. Trunk rotation in standing
2. Correction of the position of the affected lower limb to accept weight
3. Active – guided lateral weight shift
4. Removal of support from upper extremities



Picture 6: Advanced therapeutic applications in striding



1. Striding position, approximation at the shoulders and trunk extension
2. Trunk rotation with facilitation of head turn
3. Strengthening of the lower limb with ipsilateral Reaching
4. Improving activities in striding



Table 1: The development of GAIT Training

ROM	Control	Autonomy
<ul style="list-style-type: none"> • Aim: improve the range of motion to enhance proprioception • preparation in sitting • trunk mobilization, weight transfers • pre-placement of the limbs to accept weight • manual therapy techniques 	<ul style="list-style-type: none"> • Aim: to leverage the previous experience • loading of the weak limbs • development of state of readiness • Hands- On, PNF-based applications 	<ul style="list-style-type: none"> • Aim: development of the initiative of the person • problem-solving, trial and error, achievement, positive learning experience • transfer of the therapeutic outcome

