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Robotic Assistance in Locomotive Health Recovery: A review

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Abstract**: **Robotic assistance has become essential for patients with motor dysfunction, and compared to passive training, robot-assisted training with subjective locomotion intentions promotes better health recovery. In this review, the authors briefly mention robot-assisted restoration of musculoskeletal health as a pressing new field in rehabilitation. Robotic application to restore musculoskeletal health can enhance rehabilitation, but must be used according to well-defined scientific protocols. The field of robotic therapy poses challenges for both technology and clinical practice.

Keywords: Robot-Assisted Therapy, Locomotive Disorders, Locomotive Analysis, Software.

1. INTRODUCTION

Some people begin to move their bodies on their own when beginning a walk. However, for some people, walking might be exceedingly challenging owing to illness, ageing, or an injury that results in a horrible gait. An incorrect locomotive, for instance, can cause the body to be unbalanced, making it challenging to properly walk while keeping one foot in front of the other. As a result, moving from one place to another will become more challenging, barring routine tripping, stumbling, and other mishaps. Mobility is also hampered due to lack of confidence in negotiating difficult terrain.

Strength, balance, sensitivity, and coordination are necessary for a normal locomotive [1–5]. The locomotive network of the human brain has cortical and sub-cortical brain regions that monitor and regulate the coordination of many muscles functioning on different joints [6–8]. In those with brain traumas or neurological conditions, locomotive problems frequently raise major red flags [5, 10, 11]. Shorter step lengths [23, 33, 34], substantially slower walking speeds [12, 16], and disoriented locomotive variability are typical signs for locomotive disorders [13-15, 29,35].

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Due to imposed restrictions including social withdrawal, curfews, and travel restrictions, the COVID-19 epidemic has had a significant impact on human lives. People experiencing issues with locomotives have been significantly impacted by this scenario. Robotic aided locomotive therapy provided in the patient's home can be thought of as workable choices that can advance care while maintaining physical seclusion protocols, lowering the risk of exposure to the infectious virus, and defending inclined stroke survivors [17–20]. Depending on the prognosis, robot aided locomotive treatment for persons with stroke [21, 22], multiple sclerosis [23–26], Parkinson's disease [27, 28], or other degenerative diseases may involve either stationary or motion-based robots or exoskeletons traumatic brain injury [29], spinal cord injury [30-32] or hemiparesis [51]. It was observed that the disability is becoming more and more worrying for people working below the age of 65 [52].

But because there is a lack of standardisation in protocols, settings, and robotic assistance for locomotive therapies (such as amplitude and frequency of therapeutic sittings) as well as a lack of knowledge about the effects on brain reorganisation and locomotive recovery, research findings are difficult to summarise [36, 37]. Therefore, developing and standardising long-term guidelines for robot-assisted locomotive therapy is a difficult issue [22, 36,37,38, 40,41].

Therapy with robotic assistance is gaining popularity [53]. Although it was explored, it was not shown that robotic therapy, particularly for ambulatory stroke patients, was preferable to conventional therapy [54]. The control system may be the primary cause of that. Researchers proposed using robots just when the patient requested their assistance and refraining from using them while the patient was simply moving around normally [55, 56, 57]. This would solve the issue. Researchers attempted similar forms of patient-robot cooperative control strategies on the LOCOMAT robot [58, 59]. Krishnan et al. showed in their study that while there are no cooperative control robots available, they can significantly improve a patient's locomotive movement.

The direct impact of robotic assistance on biomechanized locomotives in healthy subjects has been studied by previous researchers [39,42,43,44]. Robot-assisted locomotion has been compared to unassisted locomotion, and altered movement patterns [44,48,49] have been reported. B. Higher muscle activity of the quadriceps and reduced joint angle of the lower exoskeleton for internal and external hip movements [45,46,47]. This comparison also showed that robot assistance during exercise therapy enables a physiological pattern of muscle activation [48].

Locomotion is the way a person walks. Abnormal movement or movement abnormalities occur when the body structures that control a person's gait do not function normally.

Causes of Locomotive Disorders
There are four classes of movement disorder factors. Injuries, illnesses, genetic factors, leg/foot abnormalities, Degenerative diseases such as: Arthritis, inner ear conditions, stroke, foot conditions, neurological conditions, and even ill-fitting shoes.
Type of locomotive disorders:

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The following locomotive issues are extraordinary to be mentioned,

- Propulsive locomotive - It is indicated for patients with Parkinsonism. It is classified as having a bent, unbent posture, with the head and neck bent forward. Steps are faster and shorter.
- Scissors locomotive - In this locomotion, the knees and thighs touch or move in a scissor-like pattern when walking. The legs, hips, and pelvis appear bent, giving the appearance of squatting. The steps are gradual and small. This type of locomotive is common in patients with spastic cerebral palsy.
- Spastic locomotive - Common to people with cerebral palsy or multiple sclerosis, spastic locomotion is a walking pattern in which one leg is stiff and entails a semicircular motion on the side most affected by muscle contraction during long time.
- Steppage locomotive - In the high-stepping motion, the foot is lifted high, the foot is lowered (looks supple) and the toes are lowered, touching the ground when walking. Peroneal muscle atrophy or damage to the peroneal nerve, as in the case of spinal disorders (such as spinal stenosis or herniated disc), can cause this type of locomotion.
- Waddling locomotive - The movement of the stem is amplified to produce a waddling walk similar to that of a duck. Progressive muscular dystrophy or a hip dislocation from childbirth can produce a waddling gait.

Locomotive Analysis

Locomotive analysis in a clinical setting is a valuable part of the decision-making process when initially evaluating a person and when considering the progress and effects of any treatment.

Fig.1: Locomotive analysis and sample parameters [50]

Observation gives valuable information about a persons' overall walking pattern and their ability to function. Video locomotive analysis can be useful to review features without the person being present and to save protracted locomotive observation. A few notable software packages available are BioWare/Locomotive way (KISTLER), Ariel Performance Analysis System PAS/APASLocomotive (ArielDynamics), StepPC (Median Systems), BTSwin/ Locomotive ELICLINIC (BTS Bioengineering Technology &Systems), KinTrak/OrthoTrak

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(Motion Analysis Corporation), MOTUS (Peak Performance Technologies), Vicon 250/ 512 System (VICON), SIMI Motion (DataForce), and Anthropo (SIMI).

Remedial Process

It depends on the cause. Assistive devices such as canes and walkers can also help in some situations when stability is an issue. Robotic-assisted physical remedies and enhanced training routines may be appropriate in other circumstances to improve balance, strength, and flexibility.

Effective motor health restoration can provide:

Standardized locomotive model, a symmetrical walking pattern that falls within the general range of stride length, limb position, load speed, and posture. The standardized model involves adopting a design that takes care of the affected character, where perfect stance takes precedence over everyday swings. Typically, mobility education plans include exercises that target hip extensors, ankle flexors, knee extensors, and back flexors because of a large sensitive area in any of these muscles. This can have a negative impact on skeletal muscle pattern. The training routines ensure the desired weight transfer, equal standing time and step size on each lower limb as well as increased walking speed.

Optimize -standing, -walking and running – Mobility education improves standing, walking and even running through movements to strengthen muscle and joint tissue for improved posture and balance, endurance training, leg rehabilitation for repetitive movements repetition and enhance muscle memory. Through training, people can not only stand and walk, but also can walk quickly, run and overcome useful defects. For this reason, these exercises are often recommended after an illness or to help get back to standing and walking without assistance, even if the person still wants an assistive device. Locomotive strength training is also beneficial if the person has problems moving around unassisted due to a developmental disability, stroke, accident, or age-related loss of mobility due to ataxia, and motionless.

Lower the risk of slip & fall injuries - Locomotive training reduces the risk of tremors, and an exercise routine helps to naturally realign the body and improve posture, making walking less difficult and reducing the risk of injury. In fact, the appeal of motorcycle exercises will make a man or woman feel more confident with every step, reduce soreness from poor posture and build independence. Because catastrophic falls are a major concern for older adults and physical challenges, falls are a leading cause of serious health problems and injury deaths. Robotic-assisted movement therapy reduces the general inconvenience of illness and the need for assistance in the elderly.

Progress of balance & stability – There is a direct effect of balance on walking. Without stability, it is difficult to coordinate the toes and feet as usual. In fact, every time an individual begins to stumble, the chances of falling are greatly expanded. But because stability problems can also be caused by muscle weakness or poor circulation, robotic-assisted locomotive therapy can help improve weight-bearing capacity in the legs, shifting a person's weight. side to side and back and forth until the man or woman reaches the goal. stable stability and balance. Working with the aid of a calibrated robot, the body is exposed to

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precise training routines tailored to balance problems, helping to learn to walk successfully, avoid trippingly.

Lower the risk of various illnesses - The locomotive exercise routines provide a step of exercise and movement that help reduce conditions like coronary heart disease and osteoporosis. The remedy integrates the skeletal-muscular-nerve system, eliminating limited mobility and improving cardiovascular health, lower extremity endurance, lung function and blood circulation. In addition, the exercise routine improves breathing by opening the chest cavity and restoring upright posture. In addition, movement training stimulates bowel-bladder function, improves digestion, relieves pressure, and transfers weight by allowing patients to change positions from lying or sitting to standing.

Improve cognitive-affectionate-conation wellbeing - Since vision, the inner part of the ear, and the entire musculoskeletal system are involved in gait patterns, locomotor exercises aim to correct abnormalities by taking into account all of these systems. Meanwhile, the robotic device has calibrated its operation to balance these factors, ensuring harmony in motion that eliminates tripping. The body then improves in the emotional and associative areas to experience the environment in an upright position, explore the world, and actively circumnavigate the world. By providing the ability to walk confidently and independently, the person will revel in greater awareness through exploring the environment, expanding visual perception, and improving circulation, contributing to the most suitable concentration and wisdom.

Fig.2: Locomat Hocoma a) & b) for adult, c) for child

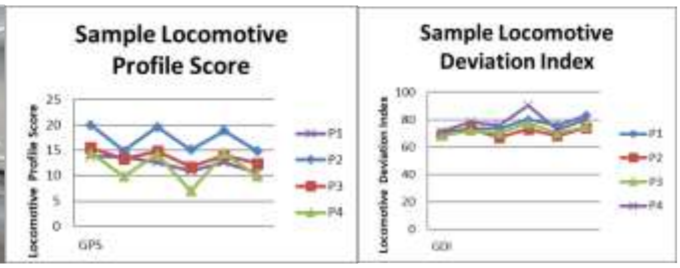

Fig.3: Impact of locomotive health recovery stages. Fig.4: Sample values of GPS and GDI

Challenges

Necessary issues are concerns about customization and high cost. The challenge of trend research is what and how to personalize and how to personalize and tailor therapeutic intervention efforts, particularly when patients show some progress. This argues for a simple

diversity training protocol, both in terms of full capacity utilization in the workspace and the types of tasks performed in the workspace.
Cost is another big issue for rehab robot approval. The price/performance ratio is unsatisfactory due to the disproportionate development costs of the extremely low benefits for the patient and clinic.

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