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Review Article

Physiotherapy Section

Altered Biomechanics of the Normal Side and the Impact on Rehabilitation of the Affected Side in Patients with Hemiplegia: A Mini Review

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ABSTRACT

Altered biomechanics is defined as the acquired alteration in the mechanics of the musculoskeletal system that leads to improper movement patterns. Hemiplegia is the reduction in strength or paralysis of one side of the body due to a stroke. The amount of involvement poststroke depends on the site of the lesion. There are various other neurological complications and associated symptoms, but the effect on biomechanics is due to alterations in the muscle strength of the unaffected side of stroke along with hemiplegia or paresis of the affected side. The unaffected side of stroke is considered to be the normal side and is thus, not considered in the treatment session, allowing it to lose its competencies, thus, the gait pattern is altered in poststroke survivors. To find the pertinent literature, electronic databases were searched using the terms "biomechanics" and "hemiplegia". The resulting articles were reviewed, the bibliography was double-checked, and pertinent literature was added. The present review article discusses the alterations in the biomechanics of the normal side and the impact on rehabilitation of patients with hemiplegia. It also provides a newer outlook to focus also, on the normal side while rehabilitation, thus, enhancing early recovery.

Keywords: Biomechanical dysfunction, Cerebrovascular accident, Non hemiplegic side, Physiotherapy, Stroke

INTRODUCTION

A stroke as defined by the World Health Organisation (WHO) is an acute, localised, or diffuse malfunction of the brain caused by blood vessels that lasts more than a day [1]. Stroke is a leading cause of death and disability in India. An infarct or hemorrhage in any area of the brain shows symptoms on the opposite side as most of the fibers cross over to the opposite side, leading to contralateral hemiplegia or hemiparesis [2]. There are already studies and research that prove this fact [3,4].

But there are only a few supporting researches about the visible sensorimotor and biomechanical alterations on the unaffected side [5-7]. The unaffected side compensates for the affected side in the acute stage poststroke. These compensatory strategies lead to biomechanical alterations in the upper and lower limb on the considered to be normal side. These alterations, in the acute stages, if neglected, may lead to major issues. Also, the uncrossed corticospinal fibers cause ipsilateral damage [2]. There are supporting researches that bilateral training has positive researchers on upper limb rehabilitation [8,9]. The amount of similar research on the lower limb is very limited [8,10,11].

From the available rehabilitation for the unaffected side, the authors witnessed, that the supposed to be normal side is actually not normal [6,8,10]. Muscle strength, weight-bearing, overactivity, gait parameters, and many other factors are affected on the unaffected side leading to biomechanical alterations. Previous evidence suggests that, performance of the unaffected upper extremity is compared with the normal individual with significant deficits in the upper extremity functions like gross manual dexterity, fine manual dexterity, motor coordination, global performance, and kinaesthesia in stroke individuals were seen [7]. This paves a path for a study, to include these results and define the biomechanical abnormalities on the affected side and its affection on the unaffected side.

Thus, the present review aims to determine the impact of altered biomechanics of the normal side on the affected side in patients with hemiplegia and how rehabilitation should be approached.

LITERATURE SEARCH

This review paper was conducted by performing a thorough research of published literature on PubMed, Scopus, and Web of Science databases which were utilised to find studies with the keywords including "hemiplegia" AND "physiotherapy" AND "altered biomechanics" AND "unaffected side" AND "normal side". The search yielded several documents, including editorials, review articles, free full texts, and abstracts. After a meticulous review, pertinent articles and their references were used to perform a search for other publications. The following criteria were used to choose these review articles: English language publication, articles published within the last 15 years, human subjects, and analytical research, experimental studies including review articles. Articles, on the other hand, were exempted because they were written in a language other than English, had been published for more than 10 years, were non human studies, or were meta-analyses or case series.

DISCUSSION

The hemiplegic side of stroke getting affected and its altered biomechanics is the focus of rehabilitation [12]. But the unaffected side of stroke is not considered to be a part of most rehabilitation protocols. The alterations on the normal side and its impact on the rehabilitation of the affected side and patients' overall performance usually goes unnoticed.

In hemiplegic patients, it is possible that a lesion in one hemisphere resulting from a vascular cause interrupts corticobulbar and corticoreticular projections and consequently affects subcortical structures involved in motor control [13]. Therefore, the integrity of these descending pathways is necessary to achieve motor performance on the unaffected side. However, the other view can be that the reduction of motor inhibition expressed as the unmasking of inhibited pathways rather than a sign of restorative change to compensate for the motor deficit [14]. That this abnormal motor inhibition may be non specific is suggested by the fact, that

it did not correlate with the different degrees of motor involvement between patients. The changes in the unaffected side and its motor disinhibition can have an impact on motor recovery as well [15]. Additionally, it's conceivable that the paretic side's weakness affects how well the unaffected side moves. It is in line with the previous studies, which stated the fact that all patients who are in the acute stage of the stroke experience motor disinhibition on both sides [6,7,15,16].

In an analytical study in 2020 by Seo JW et Al., 40 patients with stroke were recruited and compared to 28 healthy individuals and it was found that the damaged and unaffected sides' tilt range variables of trunk movement were lower than that of the healthy side, indicating intergroup variations in different gait event characteristics. The gait characteristics were severely impaired in patients with hemiplegia as compared to normal individuals [17], which proves that, the biomechanics of the supposed to be normal side are also affected.

Another study in 2019 by Selvarajan S et al., compared the gross motor strength, fine motor dexterity, reaction time audio and visual of 20 stroke patients with 20 healthy matched individuals and demonstrated the unaffected side of stroke patients had significantly reduced gross motor strength, fine motor dexterity, reaction speed audio and visual [5]. Similar findings were concluded in a descriptive study, that the ipsilateral extremities may exhibit minor abnormalities in precise movement after a stroke [18].

The biomechanical alterations during walking may be due to the impaired proprioceptive inputs from the parts of brain affected with stroke [19]. The contralateral primary motor and sensory cortices, the bilateral premotor cortical regions (Rolandic operculum and supplementary motor area), and the bilateral subcortical regions are the brain areas in charge of proprioceptive integration and processing (cerebellum, putamen) [20]. Due to the participation of both hemispheres in the proprioceptive integration process, this anatomical knowledge confirms the observation that following stroke along the paretic side, the unaffected side also exhibits proprioceptive impairments. The ability to recognise movement, be aware of its direction, and be aware of the joint position on both sides, may be compromised in stroke patients [21].

In a study by Yalcin E et al., in 2012, they stated that the stroke patients' ankles on the ipsilateral and contralateral both, displayed passive reproduction of joint position tests' dysfunction [22]. Their results showed that greater focus may be placed on the non paretic side to improve ambulation and balance, even though the rehabilitation team is often more concerned with the paretic side [15].

Niessen M et al., discovered that hemiplegic patients' non paretic shoulders have different movement patterns. They focused on changes in muscle contraction patterns, as well as, in the central integration and processing of the afferent signals, despite the fact that the cause was not clear [23]. According to Niessen MHM et al., the proprioceptive components may be impacted if this alteration also affects the afferent signals from muscle spindles. When compared to the shoulders of the healthy control group, they discovered a significant reduction in the kinaesthesia in the paretic and non paretic shoulders of the patients [24].

According to Corna S et al., the unilateral dislocation of a lower limb causes bilateral electromyographic responses in the muscles of the leg and foot [25]. Bilateral innervations of group II fibres may potentially be the cause of the altered position awareness of the contralateral kinaesthesia limb in addition to the previously noted changes in the peripheral pathways down which the group II fibres' impulses travel [26]. Kloter E et al., in an experimental study with 17 subjects found that, the functional ambulation is also affected due to normal side. Their findings point to considerable mutual impacts between unaffected and afflicted sides during poststroke locomotion, which could be leveraged to improve rehabilitation strategies [12]. Results of study by Schaefer SY et al., back up the theory that each hemisphere contributes differently to the control of starting trajectory and ultimate location, and that ipsilesional abnormalities after stroke reflect this lateralisation of control [16].

CONCLUSION(S)

The altered biomechanics of the normal side contribute to the alterations on the already affected side. When compared with healthy age, gender, and dominance-matched people, severe motor control abnormalities on the unaffected side of stroke patients were found. The uncrossed fibers contribute to the involvement on the side that should be normal while the crossing of the corticospinal tracts to the contralateral side adds to the motor deficits on the opposite side. There has only limited research on biomechanical alterations so far. The recovery process is slowed down because the normal side's biomechanics only, affect the side that is already injured. A remedy for this is, bilateral training, which promotes early and rapid recovery. For future recommendations, high-quality randomised clinical trials should be performed to establish the biomechanical aspect of the normal side affecting the abnormal side.

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