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Clinical Evaluation of Balance in Adults with Traumatic Brachial Plexus Injury

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ABSTRACT

Objectives: *The study aimed to find if the balance was impaired in patients of traumatic brachial plexus injury. The objectives were to assess the static balance using single leg stance test time and dynamic balance using the time component of modified dynamic gait index in adults with partial or complete brachial plexus injury (study group) and compare it with healthy normal adults (control group).* ***Methodology:*** *It was a cross-sectional, comparative, observational, single-center study carried out for a period of 6 months including statistical analysis. Total 20 patients with partial or complete traumatic brachial plexus injury and 20 age and gender-matched healthy normal adults were recruited from 18-45 years of age, of either gender who were willing to participate in the study. Individuals with any congenital, cognitive, vascular, neurological issues or with injuries to lower limb were excluded. Static balance was measured using single leg stance test time (in seconds) thrice for each leg (its average was then taken) and the dynamic balance was measured using the score out of 24 for time variable of modified dynamic gait index.* ***Results:*** *No statistical difference in left ($p=0.3141$) or right ($p=0.1572$) single leg stance test time was observed, however, there was a statistical difference in 'time' component of modified dynamic gait index between the 2 groups ($p<0.001$).* ***Conclusion:*** *The study shows that the static balance was not affected but the dynamic balance was affected in patients with traumatic brachial plexus injury.*

Keywords: Balance, Brachial plexus injury, Observational study

INTRODUCTION

Brachial plexus comprises of the anterior primary rami of C5-T1 spinal nerves with the occasional presence of a prefixed plexus (C4 nerve root) or postfixed plexus (T2 nerve root). It provides motor and sensory innervation to the upper limb [1].

There are essentially 3 classifications of brachial plexus injury, one on the basis of injury level with respect to dorsal root ganglion viz preganglionic and postganglionic, one with respect to site viz root, trunk, cord, or nerve level injury, and one with regards to the relation to clavicle viz supraclavicular, retroclavicular or infraclavicular plexus injury [2].

A recent epidemiological study was undertaken by Jain, et al., in an Indian center shows that major road traffic accidents occurred among 2 wheeler users and a large part of the patient group developed brachial plexus injury with a 30% increase in the incidence of the same [3].

Brachial plexus injuries with no significant spontaneous recovery are normally treated surgically and then been rehabilitated [2]. Surgeons and therapists usually aim at recovering the upper limb functions with respect to activities of daily living for a particular patient but the secondary issues which may arise including balance impairments are not considered extensively.

Balance is derived from a complex integration of the sensory system, motor system and the central nervous system [4]. It has 2 components viz static and dynamic. Static balance refers to the ability of a stationary object to maintain a balance where the object's center of gravity is on the axis of rotation. Single leg stance test is a valid and reliable test which is the temporal measure of an individual's static balance [5]. Dynamic balance, on the other hand, is the ability of an object to maintain balance while in motion or switching between positions. Modified dynamic gait index is one valid measure of dynamic balance during mobility [6]. In humans, both of these are necessary to ensure an active lifestyle.

Previous studies have shown the impact of upper limb to maintain human postural control. Studies were done on anesthesia induced axillary nerve blockage, upper limb immobilization or fatiguing arm exercises have demonstrated a negative impact on balance [7-10]. Also, altered postural control and body alignment were found in individuals who had undergone radical mastectomy [11]. Despite the available literature, there is a paucity of direct evidence in partial and complete traumatic brachial plexus injury patients, where there are a decrease and complete absence of upper limb movements, respectively, especially in the Indian population. Hence there is a need for the study.

The research question was will adults with traumatic brachial plexus injury have any impairment in balance (static and/or dynamic)? The objectives were to assess the static balance using single leg stance test time and dynamic balance using the time component of modified dynamic gait index in adults with partial and complete traumatic brachial plexus injury (study group) and compare it with that of healthy normal adults (control group).

MATERIALS AND METHODS

Study Design and Study Duration

Prior permission was obtained from the local Institutional Ethics Committee (EC/191/2016 dated 8/2/2017). It was a cross-sectional, comparative, observational, single-center study which was carried out for a period of 6 months including the statistical analysis. A purposive sampling technique was used for the recruitment of the participants.

Participants

The study was conducted in the physiotherapy outpatient department of a government tertiary care hospital. The sample included 20 patients of traumatic brachial plexus injury and 20 age and sex-matched healthy adults which were calculated on the basis of incidence of traumatic brachial plexus injury patients in the study center, with due consideration to the fallout in referral from plastic surgery out-patient department.

The study group included adults diagnosed clinically, electro-diagnostically and radiographically with unilateral brachial plexus injury, either partial or complete, who were preoperative or postoperative (beyond 6-weeks postoperative), within the age group of 18-45 years, of either gender, who were willing to participate in the study. The control group included healthy normal adults in the age group of 18-45 years, of either gender, accompanying patients to the study center and who were willing to participate in the study. Individuals with associated fractures of lower limb or with any associated cognitive problems or congenital anomalies were excluded from the study. The study materials included stopwatch, 2 cones as obstacles, stairs, 23-foot hallway, measure tape, and pen.

Written informed consent was taken from all the participants. Each participant had a single testing session. After selecting the participants based on inclusion and exclusion criteria, demographic data was taken like name, age, and gender. First, the participant was made to perform a single leg stance test (good intraclass correlation coefficients=0.95-0.99), thrice on each leg, after which the average of the values for each leg was taken. The participants were timed based on how long (in seconds) they were able to stand on one foot (60 seconds being the upper limit). They were instructed to stand as motionless as possible, maintain their hands on the iliac crests and their non-stance limb in approximately 30° of hip and knee flexion. Single leg stance test time for the right as well as left lower limb was observed and the test was concluded based on criteria's mentioned in Table 1 [5,12,13].

Table 1 Criteria's to stop single leg stance test

Criteria
The legs touched each other
The feet moved on the floor
Their foot touches down
The arms moved from their start position.

In the study group, the unaffected hand was on their iliac crest whereas their affected extremity was held in the shoulder sling (Figure 1).

Figure 1 Position for single leg stance test in the study group

In the control group, both the hands were placed on the iliac crests (Figure 2).

Figure 2 Position for single leg stance test in control group

Post this, the modified dynamic gait index (intraclass correlation 90% to 98% for time scores) was assessed in them, which is a performance-based, the therapist reported functional scale with 8 components of gait assessment as shown in Table 2 [6]. It is done across a 23 m hallway. It includes 3 components viz time, gait pattern and level of assistance. Only the time component was assessed for the above study, scoring was out of 24 [6].

Table 2 Components of modified dynamic gait index

Components of Modified Dynamic Gait Index
Gait at a level surface
Change in gait speed
Gait with horizontal head turns
Gait with vertical head turns
Gait and pivot turns
Stepping over obstacles
Stepping around obstacles
Staircase stepping

Outcome Measures

Static balance was assessed using a single leg stance test time for right and left leg in seconds. Higher the time, the better the balance. Dynamic balance was assessed using the time component of the modified dynamic gait index. It was scored out of 24. Higher the score, better the balance.

Data Analysis

The data were analyzed using GraphPad Prism 7.04 software. Normality was assessed using the Shapiro-Wilks test because it is highly sensitive for smaller sample sizes (less than 50) [14]. The data was not normally distributed hence

Mann-Whitney's test was used to compare both, the static and dynamic balance variables, amongst the study group and control group.

RESULTS

The study included 20 participants with Traumatic brachial plexus injury (TBPI). About 12 (60%) had global brachial plexus injury involving C5-T1 nerve roots, 7 (35%) had involvement of the upper trunk (C5-C6 or C5-C7 nerve roots) and only 1 participant (5%) had lower trunk involvement (C8-T1). All the injuries were endured due to road traffic accidents.

The study and the control group had 20 participants each, out of which 4 (20%) belonged to the age group 18-20 years, 10 (50%) belonged to the age group 20-30 years, 3 (15%) were from 30-40 years and 3 (15%) were from 40-45 years. All participants in the study group were right hand dominant with 11 (55%) participants having non-dominant side affection and 9 (45%) participants having dominant side affection. The study group had 18 (90%) male and 2 (10%) female participants.

With reference to Table 3, the mean value of all values of right-sided single leg stance time of control group (mean=15.61; 95% CI=12.76 to 18.47) was more than the study group (mean=13.17; 95% CI=8.627 to 17.7). Mann-Whitney test was applied to compare the 2 groups which revealed that the difference between the 2 groups was not statistically significant (p=0.1572).

Table 3 Mean and Standard deviation of right-sided single leg stance time (in seconds) in adults with brachial plexus and normal healthy adults

Variables	Adults with Traumatic Brachial Plexus Injury	Normal Healthy Adults
Sample Size	20.000	20.000
Mean	13.170	15.610
Standard Deviation	9.698	6.097
Standard Error of Mean	2.168	1.363

As seen in Table 4, the mean of all values of left-sided single leg stance time of control group (mean =17.69; 95% CI=14.2 to 21.17) was slightly more than the mean of all values of the left-sided single leg stance time of the study group (mean=17.65; 95% CI=12.42 to 22.89). Mann-Whitney test was applied to compare the 2 groups which revealed that the difference between the 2 groups was not statistically significant (p=0.3141).

Table 4 Mean and standard deviation left sided single leg stance time (in seconds) in adults with brachial plexus and normal healthy adults

Variables	Adults with traumatic brachial plexus injury	Normal Healthy Adults
Sample Size	20.000	20.000
Mean	17.650	17.690
Standard Deviation	11.180	7.445
Standard Error of Mean	2.501	1.665

As seen in Table 5 the mean value of the scores of modified dynamic gait index of the control group (mean=23; 95% CI=22.43 to 23.57) was considerably more than the mean value of scores of modified dynamic gait index of the study group (mean=15.75; 95% CI=14.04 to 17.46). Mann-Whitney test which revealed that the difference in the 2 groups was statistically significant (p<0.001).

Table 5 Mean and standard deviation of modified dynamic gait index in adults with traumatic brachial plexus injury and normal healthy adults

Variables	Adults with traumatic brachial plexus injury	Normal healthy adults
Sample Size	20.0000	20.000
Mean	15.7500	23.000
Standard Deviation	3.6540	1.214
Standard Error of Mean	0.8172	0.2714

DISCUSSION

The participants in the study group developed traumatic brachial plexus injury due to road traffic accidents. Thus the above study sample is in consensus with the epidemiological study conducted by Jain, et al., where they concluded that road traffic accidents accounted for 94% patients, with brachial plexus injury occurring in 54% patients [3].

A finding similar to studies performed by Jain, et al., and Thatte, et al., was noted where the majority of the participants in the study group had global or upper trunk injury indicating that majority suffered from supraclavicular injury. Males formed 90% of the study population with maximum participants belonged to the younger age group of 20-30 years again in consensus with the above studies [2,3].

The study sample revealed that 55% with traumatic brachial plexus injury had non-dominant hand affection. This is probably due to the fact that these patients were involved in a road traffic accident involving a fall from the 2 wheeler or were hit by the vehicles and then had a fall, where the weight of the entire body fell on the non-dominant side which eventually got affected.

To test the normality, the Shapiro-Wilks normality test was used as the sample size was less than 50. A study done by Ghasemi and Zahedias found that SPSS software recommends K-S test and Shapiro-Wilk test to be the best for samples less than 50 though K-S test is not recommended these days owing to its low power [14]. Though a recent study was done by Kevin, et al., on the specificity and sensitivity of normality tests revealed that at small sample size, normality tests may lead to erroneous use of parametric methods to build reference interval [15]. They suggest using non-parametric methods on all samples regardless of their distribution. In the study, we found that the data was not normally distributed hence non-parametric tests itself were used. Hence this factor did not affect the study.

Even though there was clinical significance (taking into consideration the mean values) in the difference of single leg stance for right leg and the left leg in controls group and patient group, the difference was not statistically significant. This could be because all individuals in the study group had been regularly following the tailor-made preoperative and postoperative neuroplastic re-education program for the affected and unaffected extremity. Analysis of the studies done previously have shown that upper limb exercises can improve the activation of lumbar core muscles (which are trunk stabilizers) and given that these patients have been trained for the upper extremity dysfunction, lumbar core activation would take place thereby improving their static balance, indirectly, over a period of time [16].

A similar study was done by Souza, et al., where they had found a statistically significant difference in both the static as well as a dynamic component of balance in individuals of brachial plexus injury as compared to normal individuals [17]. They had a smaller sample size of 11 participants and they measured the number of toe taps in single leg stance test for a period of 60 seconds unlike in our study where the single leg stance time was measured as the time period to maintain the position [12]. Also, they matched the individuals with anthropometric measurements which was not a part of our matching criteria, which is one of the factors affecting balance. They used force platforms which are more accurate in judging the sway than manual techniques hence it is possible that they got statistical significance whereas this study got no statistical significance in static balance.

The difference in the scores of modified dynamic gait index scores between the 2 groups was found to be statistically significant. All the participants in the study group witnessed an episode of trauma or road traffic accident which could have induced the component of fear in these participants [18]. Addition of these challenging tasks while walking with superadded stress of timer, increases the fear of a fall and alleviates anxiety, thereby leading to a slowing of pace to avoid further injuries and thus giving rise to a smaller score on the modified dynamic gait index as compared to the age and sex-matched healthy adults. Also, the participants with traumatic brachial plexus injury wore shoulder slings as shown in Figure 1. Previous studies have shown that berg balance scale (another variant of measure of dynamic balance) scores were lesser in individuals who wore sling than without the sling [9]. Hence it is justified that the dynamic balance is affected in participants with brachial plexus injury patient as the participants in the study group wore the slings for a considerable duration of the day.

Studies by Radwan, et al., show that balance deficiency was found in individuals of shoulder dysfunction, the greater the dysfunction the greater the affection of balance [19]. The study group had participants with partial or complete shoulder dysfunction. Hence we also got a difference in dynamic balance, though not in static balance.

CONCLUSION

There was no affection of static balance in brachial plexus injury patients but there was an affection of dynamic balance thereby implying that static, as well as dynamic balance, should be evaluated in individuals despite just upper limb injury. Balance exercises on static and dynamic bases of supports should be added to the tailor-made preoperative and postoperative physiotherapy given to the brachial plexus injury patients.

Limitation

The sample size was small as it was a post-graduate thesis which gave rise to time constraints. Also, we needed to exclude participants with lower limb injuries thereby limiting our size further. The study group was non-homogenous with different levels of lesions at different durations of onset of injury, having varying levels of disability. Therefore there is a scope for future studies.

DECLARATIONS

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Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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