Assessment of Balance in Children with Acute Lymphoblastic Leukemia

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Abstract

Purpose: This study was conducted to assess the balance in children with acute lymphoblastic leukemia within a year from termination of chemotherapy.

Methods: Six children with acute lymphoblastic leukemia participated in the study, their ages between 5 to 11 years, being assessed by Humac balance system and their balance scores were compared with thirty age and gender matched normal children.

Results: There was no significant difference (p >0.05) in balance scores in children with acute lymphoblastic leukemia while open eyes or closed eyes along with no significant difference between groups.

Conclusion: From the obtained results of the study it can be concluded that children with acute lymphoblastic leukemia have no balance affection when compared with age and gender matched children.

Keywords: Acute lymphoblastic leukemia, Chemotherapy, Balance, Humac balance system

Introduction

Acute lymphoblastic leukemia (ALL) is a heterogeneous hematologic disease, it is the most common form of leukemia in childhood [1] and it represents about 75% to 80% of acute leukemia in it [2], leukemia in general considered the most common malignancy in childhood as it accounts for 29% of all childhood cancer [3] , itaffects about 4 to 5 children in each 100,000 [4] , ALL has a peak incidence of 2 to 4 years of age [5,6] , childhood cure rates have improved to over 80% with survival rates up to 5 years event-free [7,8] , and this mainly due to recent researches and its contribution to understanding pathogenesis and molecular genetics of the disease and developing effective treatments to it [9].

Chemotherapy is considered the first line of treatment in oncology [10] , treatment of ALL in children takes within 2 - 3 years [11] , the standard chemotherapy is used to treat ALL patients like Vincristine , methotrexate , and dexamethasone causes side effects like peripheral neuropathy mainly, and problems involving cognition and behavior [12]

The term chemotherapy induced peripheral neuropathy (CIPN) has been linked to commonly used chemotherapeutic agents containing vinca alkaloids like vincristin and platinum compound like oxaliplatin [13] , it has been observed among 78% of ALL children in their first year of therapy and among 34% of cancer survivors 2 - 3 years post therapy [14]

Chemotherapy induced peripheral neuropathy is related to the intensity of treatment and dosage of chemotherapy which could affect the severity of its symptoms [15], it could result in serious problems like sensory changes and numbness , in case the sensory nerves were affected , muscle weakness and incoordination in case the affected were the motor nerves [15,16]

In addition to the psychological problems the patient experience as a result of CIPN , the patient also experience physical problems like injuries , fear of fall results from lack of sensory perception and muscle power [17]

Balance is defined as the ability to maintain the line of gravity within the base of support. [18] It is also the

ability to activate certain muscles with certain amplitude and velocity to control movement and prevent falling down [19]

Balance maintenance depends on the input provided from three systems, visual, vestibular and somatosensory systems giving information about body position in space, forces affecting it, acceleration and the surrounding environment, it also depends on motor output affecting muscle power and coordination [20, 21].

Balance can be divided into two components , static and dynamic balance [21] static balance is the ability to control postural sway and maintaining upright posture within the base of support [18, 23]while dynamic balance can be defined as the ability to perform certain task while preserving the stable position [21]

Static and dynamic balance are two critical factors in achievement of independent movement and performance of daily living activities like sitting ,standing , walking and running , transition between postures, maintaining equilibrium after certain movement and for learning fundamental movement skills such as reaching and

leaning forward or backwards [24, 25, 27] , Inappropriate balance and postural control could passively affect the child's daily living activities[28]

Balance was assessed in this study using a computerized dynamic posturography performed on the Humac Balance Board (Computer Sports Medicine, Inc., Stoughton, MA) using sensors found in the force platform for measuring multi-directional forces produced by the body movement [25] , it is based on the WII balance board technology , and it was validated in comparison with the conventional force plate[29] , it is considered as an objective , validated and portable device which is used not only as a diagnostic tool but also as a training program for balance[30].

So, the aim of this study is to assess balance in children suffered from acute lymphoblastic leukemia after the termination of their treatment program and in their first year of follow up.

Subjects, Instrumentations and Methods

Subjects:

Six Children (3 boys and 3 girls) suffered from ALL but terminated their program and in their first year of follow up participated in this study aged from

5 to 11 years, they were recruited from Tanta cancer institute, and their results were compared to thirty normal age and gender matched children (15 boys and 15 girls) ALL children having any visual or auditory problems were excluded from the study, also ALL children who had any surgical interference in their lower extremities were excluded from the study.

This study was approved from the ethics committee, Faculty of Physical Therapy, Cairo University with number: P.T.REC/012/001712. After a clear explanation of the study procedure a consent form was signed and obtained from the children parents or caregivers.

Material for evaluation;

The Humac balance system was utilized to assess Sensory integration of balance using the modified Clinical Test of Sensory Integration of Balance (mCTSIB) in the conditions of eyes opened and eyes closed on the platform and it was proved to have a great inter rater and test- retest reliability.[25, 26]

Procedure

Patient was instructed to assume stride standing on the force platform (placed 3 feet from the wall) barefoot with arms beside him , after recording the position of each foot on the platform (as the platform is divided into vertical and horizontal lines for determining foot position from the position of medial malleolus , and also its angle).

The test is started with ordering patient to look on a target on the wall placed at the level of his eyes for 30 second (in the condition of eyes open), and then he was ordered to close his eyes (in the condition of eyes closed) for 30 second, each condition was repeated for 3 times and the overall stability record was measured from each trial and the mean value was calculated.

Statistical Analysis

Statistical analysis was conducted using SPSS for windows, version 22 (SPSS, Inc., Chicago, IL). The current test involved two independent variables. The first one was the (tested group); between subject factors which had two levels (group A represent control group which include completly normal children matching in age and gender with group B and group B represent study group which include children suffered from ALL but terminated their treatment program and

in their first year of follow up). The second one was the (conditions) ; within subject factor which had two levels (open eye, closed eye). In addition, this test involved one tested dependent variables (mCTSIB score). There were no outliers, as assessed by boxplot. The data was normally distributed, as assessed by Shapiro-Wilk's test of normality (p > .05). There was homogeneity of variances (p > .05) and covariances (p > .05), as assessed by Levene's test of homogeneity of variances and Box's M test,

respectively. Accordingly, 2×2 mixed design univariate analysis of variance (ANOVA) with post hoc comparisons was used to compare the tested dependent variable within and between the two groups at two conditions (open- and closed-eye). The ANOVA was conducted with the initial alpha level set at 0.05.

RESULTS

demographic data

There were no statistically significant differences (P>0.05) between subjects in both groups concerning age (Table 1).

Table (1): Demographic characteristics of both groups:

	Group A	Group B	Comparison	
	Mean ± SD	Mean ± SD	t-value	P-value
Age (years)	8±2.03	7.5±2.34	0.532	0.598

SD: standard deviation, P: probability

There was no statistically significant interaction between the tested group and condition on mCTSIB score, $F= 4.98, p = .05$, partial $\eta^2 = .135$. The main effect of condition showed no statistically significant difference in mean mCTSIB score at the different conditions, $(F= 0.636, p < 0.431)$, partial $\eta2 = .019$. The main

effect of tested group showed that there was no statistically significant difference in mean mCTSIB score between both groups $F= 1.572, p = .219$, partial $\eta2 = .047$. Table (2) present descriptive statistic and multiple pairwise comparison tests (Post hoc tests) for mCTSIB score. In the same context, the multiple pairwise

comparison tests revealed that there was no significant difference (p >0.05) in mCTSIB score in the open eye condition compared with the closed eye one in both groups. Regarding between subject effects multiple pairwise comparisons revealed that there was no significant difference (p >0.05) in mCTSIB score when compared group A with group B at both conditions (open and closed eye).

Table (2): Descriptive statistic and multiple pairwise comparison tests (Post hoc tests) for the mCTSIB score for both groups at different conditions.

Table (2): Mean +SD of mCTSIB scores while eye open and closed of both groups:

mCTSIB Score	Means ± SD	Means ± SD	P- value
	Open eye	Closed eye	
Group A	87.38±5.99	85.52±5.1	0.098
Group B	81.22±13.63	85.16±3.74	0.105
P- value	0.085	0.872	

*Significant level is set at alpha level <0.05

DISCUSION

This study was designed to assess the balance in ALL survivors within a year from termination of chemotherapy, as ALL represents the most common malignancy in childhood and recently there was improvement in the survival rates among patients, so more attention had to be taken to study the side effects of treatment among survivors (especially balance as it is one of the least studied problems in cancer patients). [30]

According to systematic review performed by *Varedi et al.*[30], the affection of balance in ALL children is somehow equivocal as some studies showed significant balance affection among patients.

The results of this study revealed that there was no significant difference between ALL survivors' balance and normal children.

The results obtained by this study may be due to that ALL survivors enrolled in this study had/hadn't peripheral neuropathy resulting in minimal or no balance affection in these subjects.

This comes in agreement with **Gilchrist, 2012**[15] who reported that CIPN is related to the intensity of treatment and dosage of chemotherapy which could affect the severity of its symptoms.

The results of the study may be due to diminished or vanished effect of chemotherapy on peripheral nerves integrity and subsequent muscle weakness and incoordination.

This comes in agreement with **Messelink, 1999** [32] who studied the motor skills by the Movement Assessment Battery for Children (MABC) in children aged 4 to 12 years, they assessed them through 5 points of therapy t1: one week before therapy, t2: one week after 4th dose and end of induction phase, t3: one week before fifth dose, t4: one week after the 8th dose and t5:6 month after the 8th dose, it showed balance affection after the end of induction phase but this affection diminished after the re-induction phase.

Also the results of the study comes in agreement with **De luca et al .2013**[33] who used the MABC II to assess motor skills and had a general result of no significant difference in balance when assessed in three groups

group 1 within 1 year after therapy, group 2 within 1 – 2 years after therapy and group 3 from 25 to 60 month after therapy and the results showed 10% affection in group 1 and 30% in group 2 and no balance affection in group 3)

The results of this study disagrees with *Wright et al. 1998*[34] who used the Bruininks - Oseretsky Test of Motor Proficiency (BOTMP) to study motor performance among survivors after 1 year of therapy aged from 5 to 14 years and the study group showed lower performance concerning balance than the healthy group.

Conclusion:

The results of the study revealed that, there were no significant difference between the scoring of the two conditions in the two groups , also the statistical analysis showed no significance difference in the scoring of the study groups compared with the control group , in other words the study group showed no deviation of their results from the control group reflecting no balance problem.

These results could be affected by the limitations concerning the sample size utilized in this study , also

despite the positive point concluded that the survivors balance is intact , this is not enough evidence to claim that the chemotherapeutic agents have no direct impact on balance as this could occur during the treatment period and recovers gradually after its termination .

So another study with larger sample size and study including patients within their treatment period are recommended for further investigations and more detailed pictures concerning balance status in patients and survivors.

Declaration of interests

The authors declare no conflict of interest.

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