

## RESULTS

The purpose of this study was to investigate the effect of lower limb sensory training on postural stability in patients with stroke. Thirty male patients with stroke participated in this study. Subjects were divided into two groups, fifteen subjects in each group. Group A received active and passive sensory based interventions and a selected physiotherapy program, and group B received the selected physiotherapy program.

Data obtained from both groups pre and post treatment regarding anteroposterior stability index (APSI), mediolateral stability index (MLSI), overall stability index (OASI) with eye open and eye closed conditions. Also, Berg balance scale (BBS) were statistically analysed and compared.

### **General characteristics of the subjects:**

#### **Group A:**

The mean  $\pm$  SD age, weight, height and BMI of the group A were  $56.8 \pm 4.36$  years,  $78.26 \pm 9.6$  kg,  $166.73 \pm 7.42$  cm and  $28.26 \pm 4$  kg/m<sup>2</sup> respectively (Table2, figure 22-25).

#### **Group B:**

The mean  $\pm$  SD age, weight, height and BMI of the group B were  $55.86 \pm 5.38$  years,  $77.6 \pm 7.89$  kg,  $168.13 \pm 9.79$  cm and  $27.52 \pm 2.61$  kg/m<sup>2</sup> respectively (Table2, figure 22-25).

Comparing the general characteristics of the subjects of both groups revealed that there was no significance difference between groups in the mean age, weight, height and BMI ( $p > 0.05$ ).

**Comparison of age, weight, height and BMI between the group A and B.**

	Group A	Group B	MD	t- value	p-value	Sign
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
Age (years)	56.8 $\pm$ 4.36	55.86 $\pm$ 5.38	0.94	0.52	0.61	NS
Weight (kg)	78.26 $\pm$ 9.6	77.6 $\pm$ 7.89	0.66	0.21	0.83	NS
Height (cm)	166.73 $\pm$ 7.42	168.13 $\pm$ 9.79	-1.4	-0.44	0.66	NS
BMI (kg/m <sup>2</sup> )	28.26 $\pm$ 4	27.52 $\pm$ 2.61	0.74	0.59	0.55	NS

$\bar{x}$ : mean

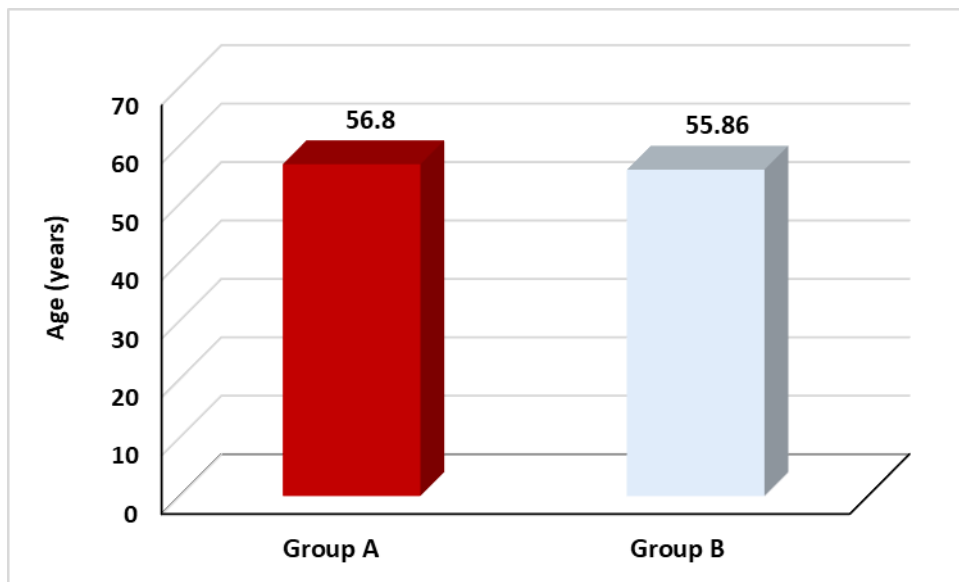
SD: Standard deviation

MD: mean difference

t value: Unpaired t value

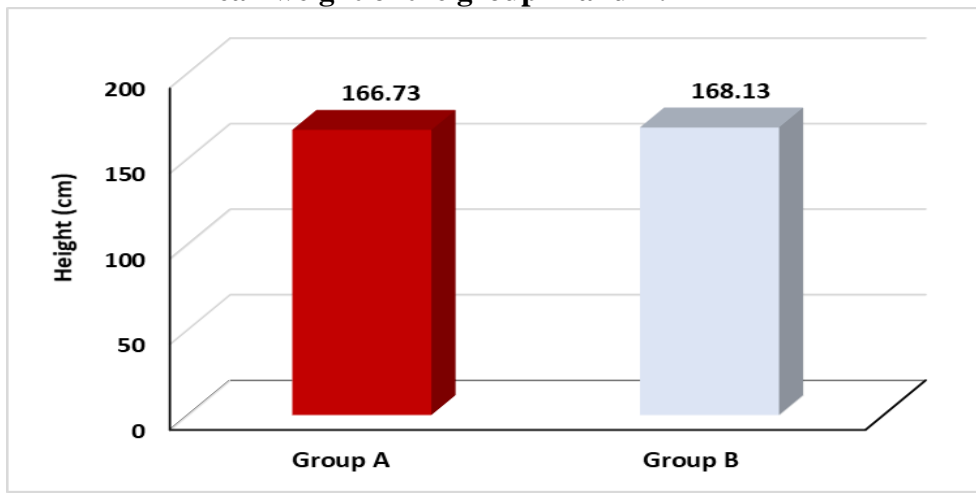
p value: Probability value

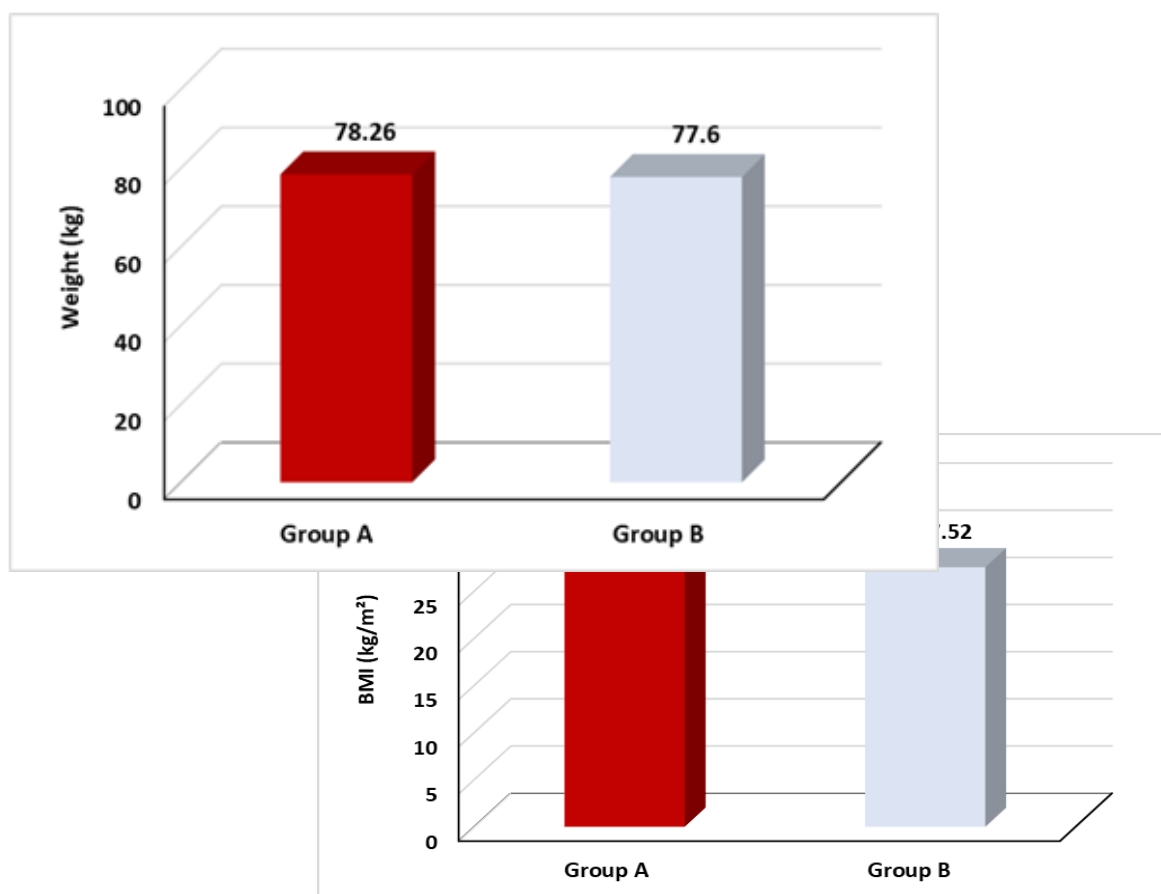
NS: Non significant



**Mean age of the group A and B.**

**Mean weight of the group A and B.**





**Mean BMI of the group A and B.**

**- Effect of treatment on APSI, MLSI, OASI and BBS:**

Mixed MANOVA was conducted to investigate the effect of treatment on APSI, MLSI, OASI and BBS. There was a significant interaction effect of treatment and time ( $p = 0.001$ ). There was a significant main effect time ( $p = 0.0001$ ). There was a significant main effect of treatment ( $p = 0.04$ ). (Table 2).

**Mixed MANOVA for the effect of treatment on APSI, MLSI, OASI and BBS:**

Mixed MANOVA		
Interaction effect (treatment * time)		
$F = 5.41$	$p = 0.001$	<i>S</i>
Effect of time		
$F = 113.51$	$p = 0.0001$	<i>S</i>
Effect of treatment		
$F = 2.53$	$p = 0.04$	<i>S</i>

**F value: Mixed MANOVA F value   p value: Probability value   S: Significant**

## **I- Effect of treatment on APSI with eye opened:**

### **Within group comparison**

#### **Group A:**

The mean  $\pm$  SD APSI with eye opened pre treatment of the group A was  $2.74 \pm 0.93$  while post treatment was  $1.61 \pm 0.52$ . The mean difference was 1.13, and the percent of change was 41.24%. There was a significant decrease in APSI with eye opened in the group A post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 4, figure 26).

#### **Group B:**

The mean  $\pm$  SD APSI with eye opened pre treatment of the group B was  $2.91 \pm 0.79$  while post treatment was  $2.26 \pm 0.61$ . The mean difference was 0.65, and the percent of change was 22.34%. There was a significant decrease in APSI with eye opened in the group B post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 4, figure 26).

### **Comparison between groups**

#### **Pre treatment**

The mean difference in APSI with eye opened between the group A and B pre treatment was -0.17. There was no significant difference in the APSI with eye opened between groups pre treatment ( $p = 0.59$ ). (Table 4).

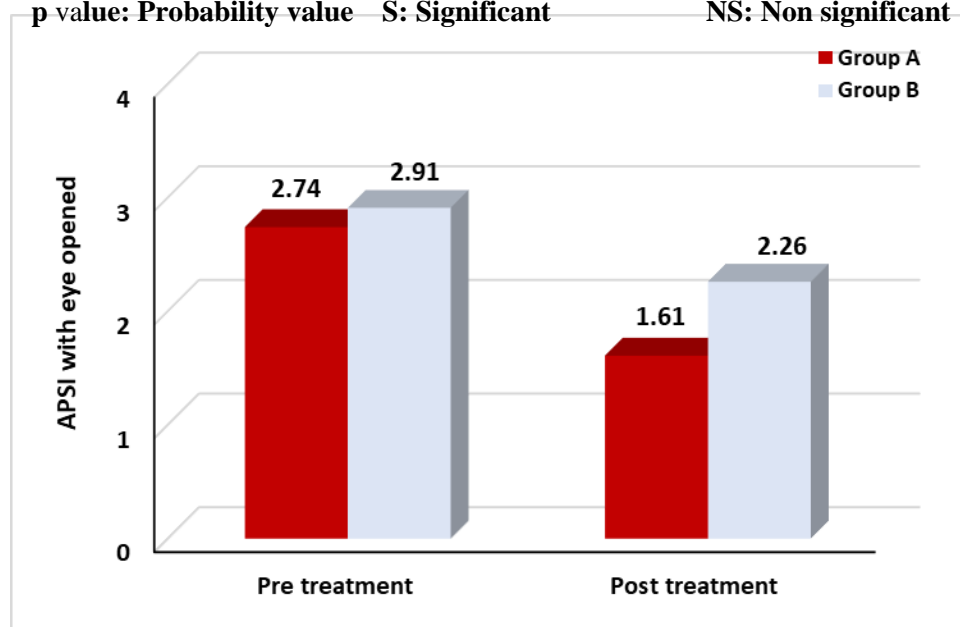
#### **Post treatment**

The mean difference in APSI with eye opened between the group A and B post treatment was -0.65. There was a significant decrease in APSI with eye opened of the group A compared with that of group B post treatment ( $p = 0.004$ ). (Table 4).

**Mean APSI with eye opened pre and post treatment of the group A and B.**

APSI with eye opened	Pre treatment	Post treatment	MD	% of change	P-value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
Group A	$2.74 \pm 0.93$	$1.61 \pm 0.52$	1.13	41.24	0.0001	S
Group B	$2.91 \pm 0.79$	$2.26 \pm 0.61$	0.65	22.34	0.0001	S
MD	-0.17	-0.65				
P-value	0.59	0.004				
Sig	NS	S				

$\bar{X}$  : Mean                      SD: Standard deviation    MD: Mean difference  
p value: Probability value    S: Significant                      NS: Non significant



Mean APSI with eye opened pre and post treatment of the group A and B.

## II- Effect of treatment on APSI with eye closed:

Within group comparison

Group A:

The mean  $\pm$  SD APSI with eye closed pre treatment of the group A was  $5.68 \pm 1.35$  while post treatment was  $3.48 \pm 0.98$ . The mean difference was 2.2, and the percent of change was 38.73%. There was a significant decrease in APSI with eye closed in the group A post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 3, figure 5).

### **Group B:**

The mean  $\pm$  SD APSI with eye closed pre treatment of the group B was  $6.39 \pm 1.02$  while post treatment was  $4.81 \pm 1.12$ . The mean difference was 1.58, and the percent of change was 24.73%. There was a significant decrease in APSI with eye closed in the group B post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 5, figure 27).

### **Comparison between groups**

#### **Pre treatment**

The mean difference in APSI with eye closed between the group A and B pre treatment was -0.71. There was no significant difference in the APSI with eye closed between groups pre treatment ( $p = 0.11$ ). (Table 5).

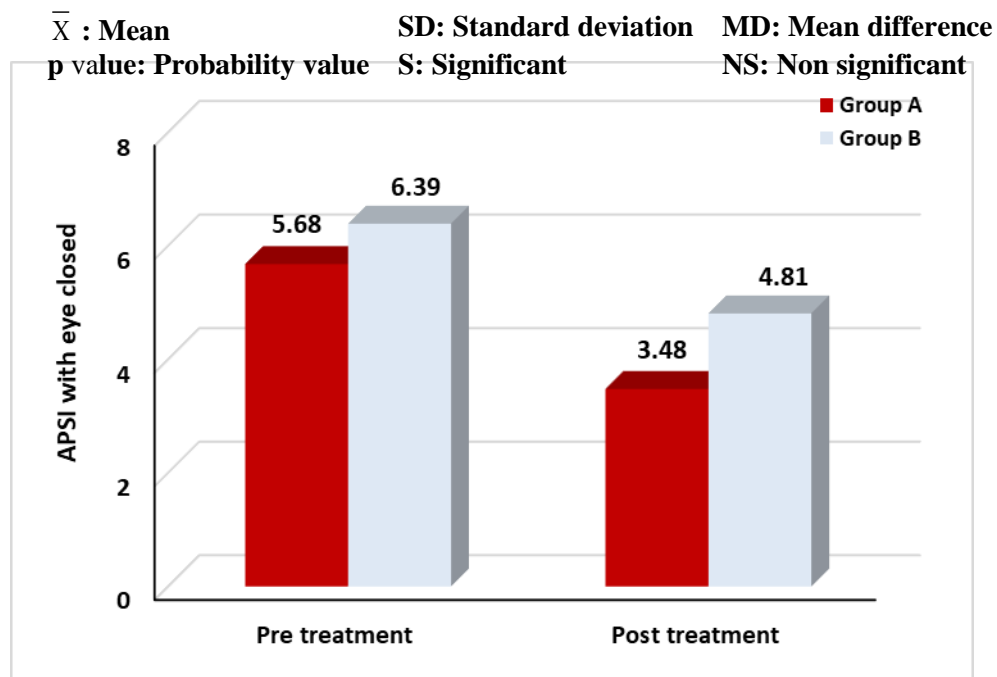
#### **Post treatment**

The mean difference in APSI with eye closed between the group A and B post treatment was -1.33. There was a significant decrease in APSI with eye closed of the group A compared with that of group B post treatment ( $p = 0.002$ ). (Table 5).

**Mean APSI with eye closed pre and post treatment of the group A and B.**

APSI with eye	Pre treatment	Post treatment	MD	% of	P-value	Sig
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closed	$\bar{X} \pm SD$	$\bar{X} \pm SD$		change		
Group A	$5.68 \pm 1.35$	$3.48 \pm 0.98$	2.2	38.73	0.0001	S
Group B	$6.39 \pm 1.02$	$4.81 \pm 1.12$	1.58	24.73	0.0001	S
MD	-0.71	-1.33				
P-value	0.11	0.002				
Sig	NS	S				



Mean APSI with eye closed pre and post treatment of the group A and B.

#### IV- Effect of treatment on MLSI with eye opened:

Within group comparison

Group A:



The mean  $\pm$  SD MLSI with eye opened pre treatment of the group A was  $2.71 \pm 0.62$  while post treatment was  $1.73 \pm 0.39$ . The mean difference was 0.98, and the percent of change was 36.16%. There was a significant decrease in MLSI with eye opened in the group A post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 6, figure 28).

### **Group B:**

The mean  $\pm$  SD MLSI with eye opened pre treatment of the group B was  $2.81 \pm 0.55$  while post treatment was  $2.26 \pm 0.45$ . The mean difference was 0.55, and the percent of change was 19.57%. There was a significant decrease in MLSI with eye opened in the group B post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 6, figure 28).

### **Comparison between groups**

#### **Pre treatment**

The mean difference in MLSI with eye opened between the group A and B pre treatment was -0.1. There was no significant difference in the MLSI with eye opened between groups pre treatment ( $p = 0.6$ ). (Table 6).

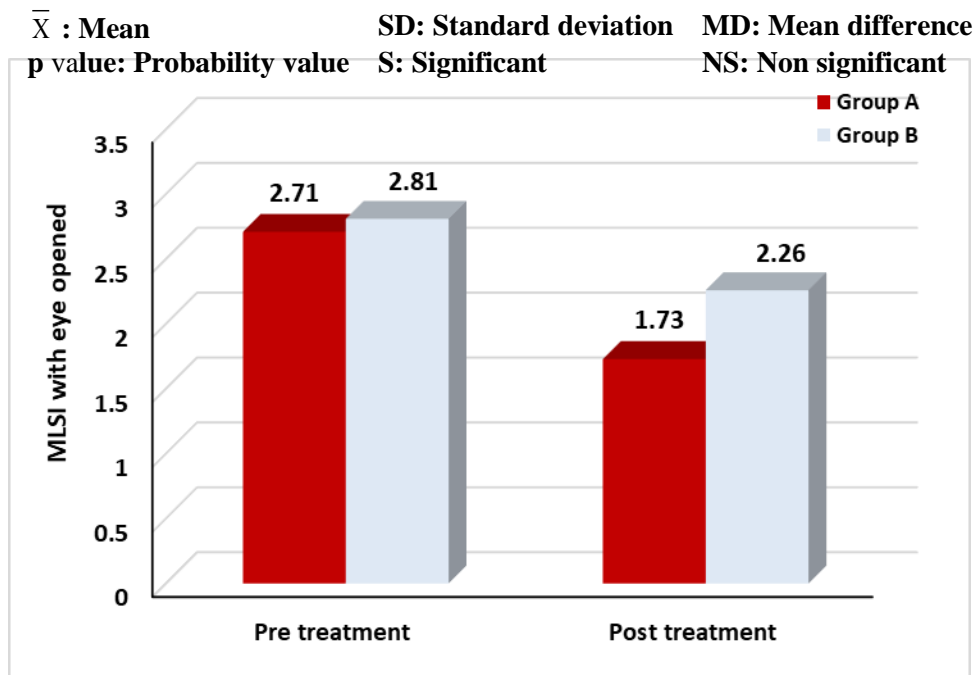
#### **Post treatment**

The mean difference in MLSI with eye opened between the group A and B post treatment was -0.53. There was a significant decrease in MLSI with eye opened of the group A compared with that of group B post treatment ( $p = 0.002$ ). (Table 6).

**Mean MLSI with eye opened pre and post treatment of the group A and B.**

MLSI with eye opened	Pre treatment	Post treatment	MD	% of change	p-value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				

<b>Group A</b>	2.71 ± 0.62	1.73 ± 0.39	0.98	36.16	0.0001	<b>S</b>
<b>Group B</b>	2.81 ± 0.55	2.26 ± 0.45	0.55	19.57	0.0001	<b>S</b>
<b>MD</b>	-0.1	-0.53				
<b>p-value</b>	0.6	0.002				
<b>Sig</b>	NS	S				



**Mean MLSI with eye opened pre and post treatment of the group A and B.**

### **III- Effect of treatment on MLSI with eye closed:**

#### **Within group comparison**

##### **Group A:**

The mean ± SD MLSI with eye closed pre treatment of the group A was  $5.31 \pm 1.15$  while post treatment was  $3.16 \pm 0.78$ . The mean difference was 2.15, and the percent of change was 40.49%. There was a significant decrease in MLSI

with eye closed in the group A post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 7, figure 29).

### **Group B:**

The mean  $\pm$  SD MLSI with eye closed pre treatment of the group B was  $5.69 \pm 0.94$  while post treatment was  $3.83 \pm 0.81$ . The mean difference was 1.86, and the percent of change was 32.69%. There was a significant decrease in MLSI with eye closed in the group B post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 7, figure 29).

### **Comparison between groups**

#### **Pre treatment**

The mean difference in MLSI with eye closed between the group A and B pre treatment was -0.38. There was no significant difference in the MLSI with eye closed between groups pre treatment ( $p = 0.33$ ). (Table 7).

#### **Post treatment**

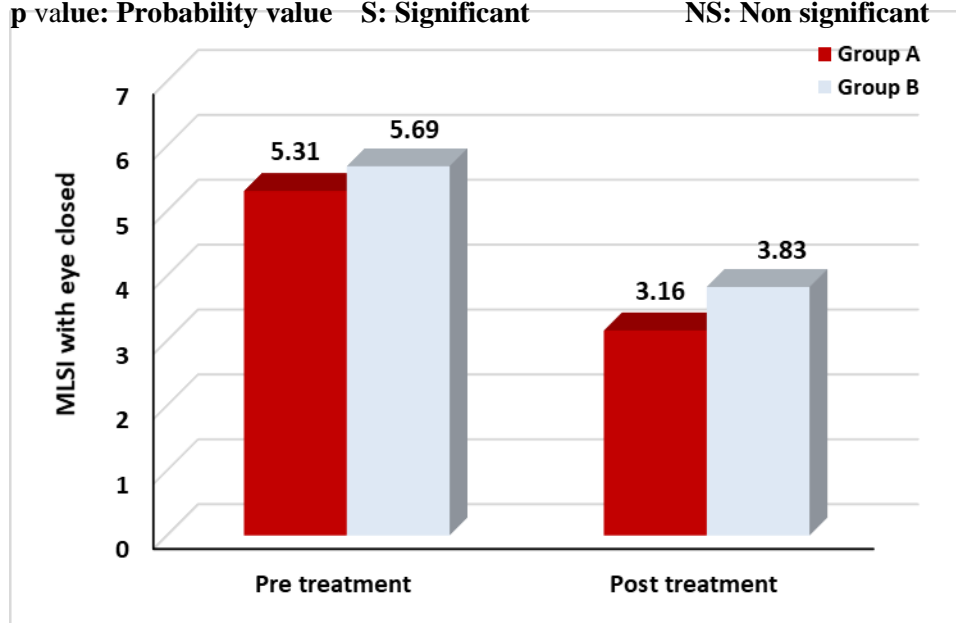
The mean difference in MLSI with eye closed between the group A and B post treatment was -0.67. There was a significant decrease in MLSI with eye closed of the group A compared with that of group B post treatment ( $p = 0.02$ ). (Table 7).

**Mean MLSI with eye closed pre and post treatment of the group A and B.**

MLSI with eye closed	Pre treatment	Post treatment	MD	% of change	P-value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
<b>Group A</b>	$5.31 \pm 1.15$	$3.16 \pm 0.78$	2.15	40.49	0.0001	S
<b>Group B</b>	$5.69 \pm 0.94$	$3.83 \pm 0.81$	1.86	32.69	0.0001	S
<b>MD</b>	-0.38	-0.67				
<b>P-value</b>	0.33	0.02				

Sig	NS	S	
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$\bar{X}$  : Mean      SD: Standard deviation      MD: Mean difference  
 p value: Probability value      S: Significant      NS: Non significant



Mean MLSI with eye closed pre and post treatment of the group A and B.

## **VI- Effect of treatment on OASI with eye opened:**

### **Within group comparison**

#### **Group A:**

The mean  $\pm$  SD OASI with eye opened pre treatment of the group A was  $3.95 \pm 0.97$  while post treatment was  $2.57 \pm 0.65$ . The mean difference was 1.38, and the percent of change was 34.94%. There was a significant decrease in OASI with eye opened in the group A post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 8, figure 30).

#### **Group B:**

The mean  $\pm$  SD OASI with eye opened pre treatment of the group B was  $4.15 \pm 0.8$  while post treatment was  $3.08 \pm 0.54$ . The mean difference was 1.07, and the percent of change was 25.78%. There was a significant decrease in OASI

with eye opened in the group B post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 8, figure 30).

## Comparison between groups

### Pre treatment

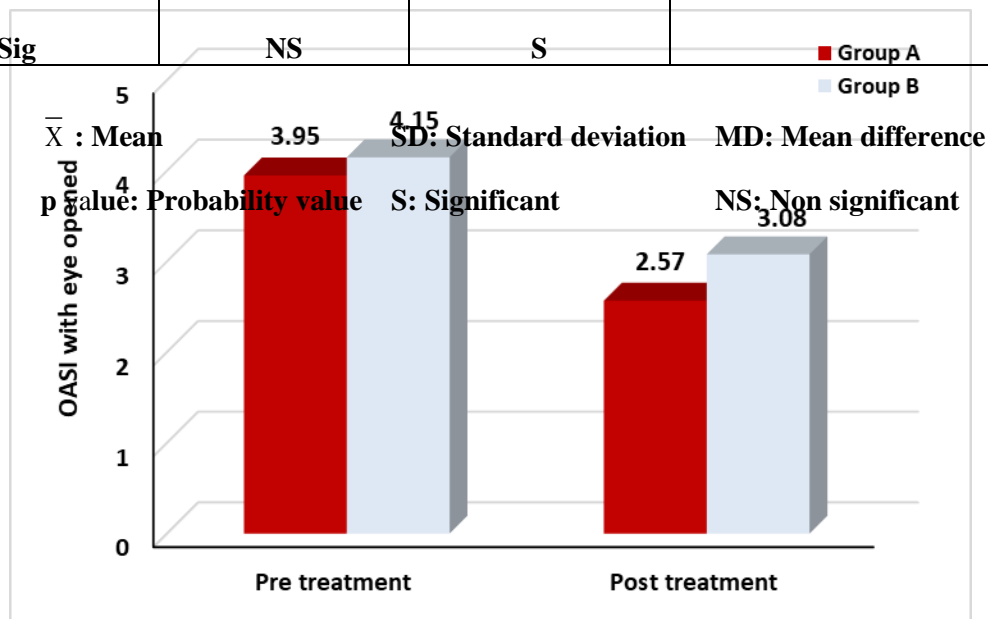
The mean difference in OASI with eye opened between the group A and B pre treatment was -0.2. There was no significant difference in the OASI with eye opened between groups pre treatment ( $p = 0.55$ ). (Table 8).

### Post treatment

The mean difference in OASI with eye opened between the group A and B post treatment was -0.51. There was a significant decrease in OASI with eye opened of the group A compared with that of group B post treatment ( $p = 0.02$ ). (Table 8).

**Mean OASI with eye opened pre and post treatment of the group A and B.**

OASI with eye opened	Pre treatment	Post treatment	MD	% of change	P-value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
Group A	$3.95 \pm 0.97$	$2.57 \pm 0.65$	1.38	34.94	0.0001	S
Group B	$4.15 \pm 0.8$	$3.08 \pm 0.54$	1.07	25.78	0.0001	S
MD	-0.2	-0.51				
P-value	0.55	0.02				
Sig	NS	S				



**Mean OASI with eye opened pre and post treatment of the group A and B.**

**V- Effect of treatment on OASI with eye closed:**

**Within group comparison**

**Group A:**

The mean  $\pm$  SD OASI with eye closed pre treatment of the group A was  $5.97 \pm 0.96$  while post treatment was  $3.17 \pm 0.57$ . The mean difference was 2.8, and the percent of change was 46.9%. There was a significant decrease in OASI with eye closed in the group A post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 9, figure 31).

**Group B:**

The mean  $\pm$  SD OASI with eye closed pre treatment of the group B was  $5.93 \pm 0.85$  while post treatment was  $4.03 \pm 0.53$ . The mean difference was 1.9, and the percent of change was 32.04%. There was a significant decrease in OASI with eye closed in the group B post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 9, figure 31).

**Comparison between groups**

**Pre treatment**

The mean difference in OASI with eye closed between the group A and B pre treatment was 0.04. There was no significant difference in the OASI with eye closed between groups pre treatment ( $p = 0.9$ ). (Table 9).

## Post treatment

The mean difference in OASI with eye closed between the group A and B post treatment was -0.86. There was a significant decrease in OASI with eye closed of the group A compared with that of group B post treatment ( $p = 0.0001$ ). (Table 9).

**Mean OASI with eye closed pre and post treatment of the group A and B.**

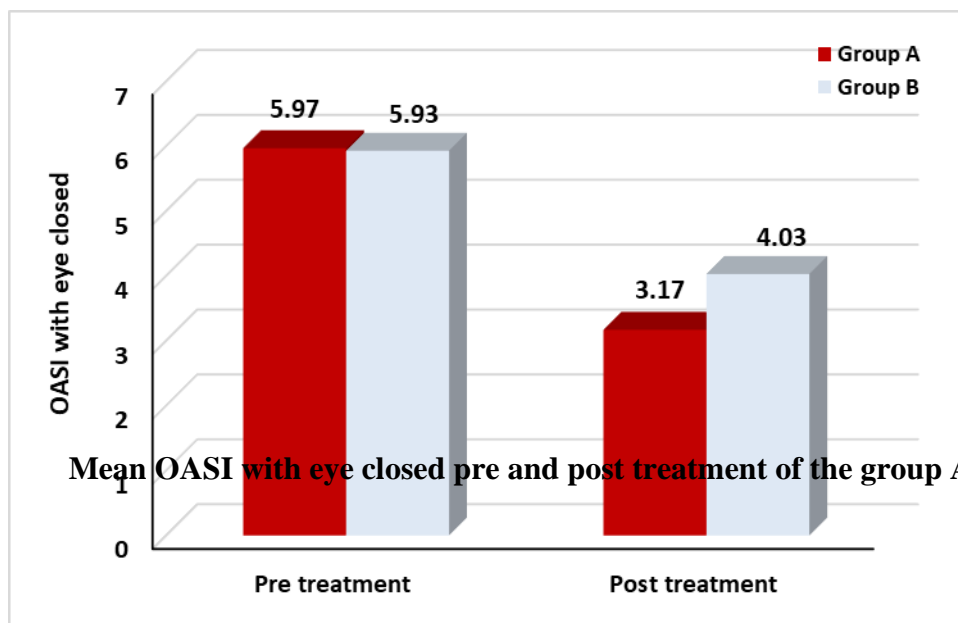
OASI with eye closed	Pre treatment	Post treatment	MD	% of change	P-value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
Group A	$5.97 \pm 0.96$	$3.17 \pm 0.57$	2.8	46.90	0.0001	S
Group B	$5.93 \pm 0.85$	$4.03 \pm 0.53$	1.9	32.04	0.0001	S
MD	0.04	-0.86				
P-value	0.9	0.0001				
Sig	NS	S				

$\bar{X}$  : Mean

SD: Standard deviation MD: Mean difference

p value: Probability value S: Significant

NS: Non significant



## **VII- Effect of treatment on BBS:**

### **Within group comparison**

#### **Group A:**

The mean  $\pm$  SD BBS pre treatment of the group A was  $51.06 \pm 2.12$  while post treatment was  $56.2 \pm 1.2$ . The mean difference was -5.14, and the percent of change was 10.07%. There was a significant increase in BBS in the group A post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 10, figure 32).

#### **Group B:**

The mean  $\pm$  SD BBS pre treatment of the group B was  $50.8 \pm 2.14$  while post treatment was  $53.6 \pm 1.88$ . The mean difference was -2.8, and the percent of change was 5.51%. There was a significant increase in BBS in the group B post treatment compared with that pre treatment ( $p = 0.0001$ ). (Table 10, figure 32).

### **Comparison between groups**

#### **Pre treatment**

The mean difference in BBS between the group A and B pre treatment was 0.26. There was no significant difference in the BBS between groups pre treatment ( $p = 0.73$ ). (Table 10).

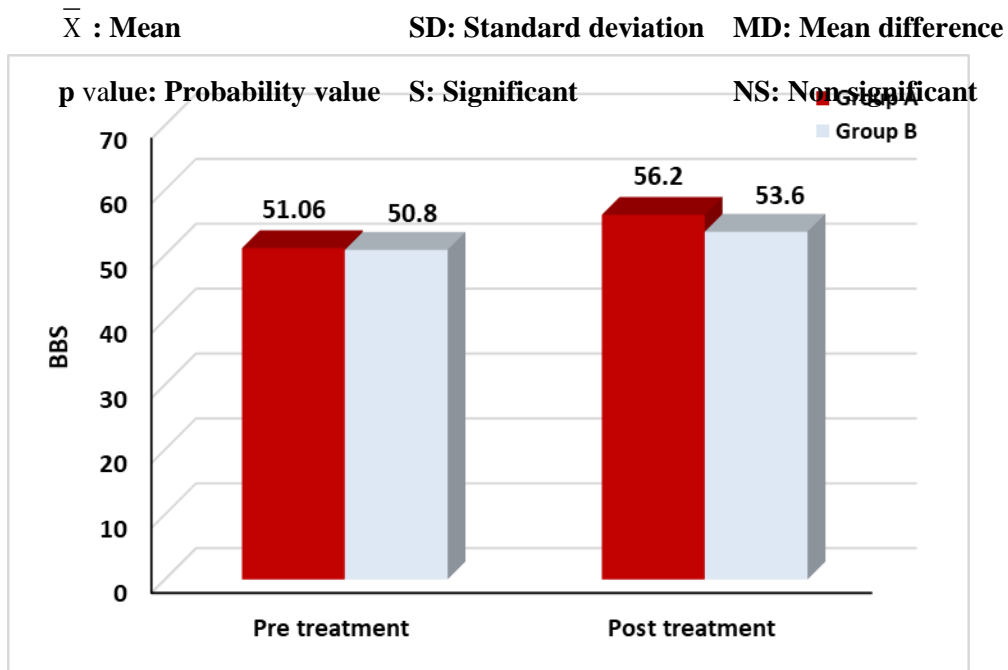
#### **Post treatment**

The mean difference in BBS between the group A and B post treatment was 2.6. There was a significant increase in BBS of the group A compared with that of group B post treatment ( $p = 0.0001$ ). (Table 10).



**Mean BBS pre and post treatment of the group A and B.**

BBS	Pre treatment	Post treatment	MD	% of change	P-value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
Group A	51.06 $\pm$ 2.12	56.2 $\pm$ 1.2	-5.14	10.07	0.0001	S
Group B	50.8 $\pm$ 2.14	53.6 $\pm$ 1.88	-2.8	5.51	0.0001	S
MD	0.26	2.6				
P-value	0.73	0.0001				
Sig	NS	S				



**Mean BBS pre and post treatment of the group A and B.**

## Summary of the results:

### a) The Biodex balance system indices:

- There was a significant decrease in the values of the anteroposterior stability index (APSI), the mediolateral stability index (MLSI), and the overall stability index (OASI) in both eyes open and eyes closed conditions within both groups post-treatment compared to pretreatment.
- There was a significant decrease in the values of the anteroposterior stability index (APSI), the mediolateral stability index (MLSI), and the overall stability index (OASI) in the eyes open condition of group A compared with that of group B post-treatment.
- There was a significant decrease in the values of the anteroposterior stability index (APSI), the mediolateral stability index (MLSI), and the overall stability index (OASI) in the eyes closed condition of group A compared with that of group B post-treatment.

**b) The Berg balance scale score:**

- There was a significant increase in the Berg Balance Scale score in group B post-treatment compared with that pre-treatment.
- There was a significant increase in the Berg Balance Scale score of group A compared with that of group B post-treatment.