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Three Dimensional Assessment of Maxillary Molars Following Distalization Using Two Different Approaches

A Thesis
Submitted to Faculty of Dentistry
Ain-Shams University
In Partial Fulfillment of the Requirements of
Master's Degree in Orthodontics

Faculty of Dentistry
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Statistical analysis

Statistical analysis was performed with SPSS 20®*, Graph Pad Prism®**, and Microsoft Excel 2016***.

All quantitative data were explored for normality by using Shapiro Wilk Normality test and presented as means and standard deviation (SD) values. All qualitative data were presented as frequency & percentage. All data were presented in (43) tables & (38) graphs.

Tests used:

- Comparisons 2 different groups was performed by using Mann Whitney test.
- Comparisons 2 successive follow ups periods was performed by using Paired t-test.
- Comparison between quantitative continuous data (Age & Duration) was performed by Independent t-test.
- Comparison between qualitative dichotomous data (Gender) was performed by Chi square test.
- Reliability test was performed by using Intra-class Correlation Coefficient (ICC).

* Statistical Package for Social Science, IBM, Armonk, NY, USA.
** Graph Pad Technologies, San Diego, CA, USA
*** Microsoft Co-operation, Redmond, WA, USA.

* **All results presented as:**

I. **Normality test.**

II. **Baseline characteristics:**

A. Age.

B. Gender.

C. Duration

D. Pretreatment measurements. (Appendix IV).

III. **Measurements**

The following measurements were carried for both group I and group II as well as in comparison between the two groups.

A. Skeletal measurements

1. Skeletal antero-posterior measurements.
2. Skeletal vertical measurements.

B. Dental measurements

1. Angular
2. Linear

C. Soft tissue measurements.

IV. **Reliability:** (Appendix V)

A. Inter-observer.

B. Intra-observer.

I. Normality test:

Exploration of the given data was performed using Shapiro-Wilk test and Kolmogorov-Smirnov test for normality. As Listed in **(Table 11)** and showed in **(Figure 53),** it was revealed that the significant level (P-value) was shown to be insignificant as P-value > 0.05, which indicated that alternative hypothesis was rejected, and the concluded data originated from normal distribution (parametric data) resembling normal Bell curve in pre & post measurements while P value was significant in the difference between both groups which indicated nonparametric data.

Table (11): Normality exploration of both groups regarding all measurements:

Measurements		Group I Single Coil Spring	Group II Double Coil Spring
Skeletal.	Pre	> 0.05	> 0.05
	Post	> 0.05	> 0.05
	Difference	< 0.05*	< 0.05*
Dental	Pre	> 0.05	> 0.05
	Post	> 0.05	> 0.05
	Difference	< 0.05*	< 0.05*
Soft tissue	Pre	> 0.05	> 0.05
	Post	> 0.05	> 0.05
	Difference	< 0.05*	< 0.05*

** Significant difference as P < 0.05*

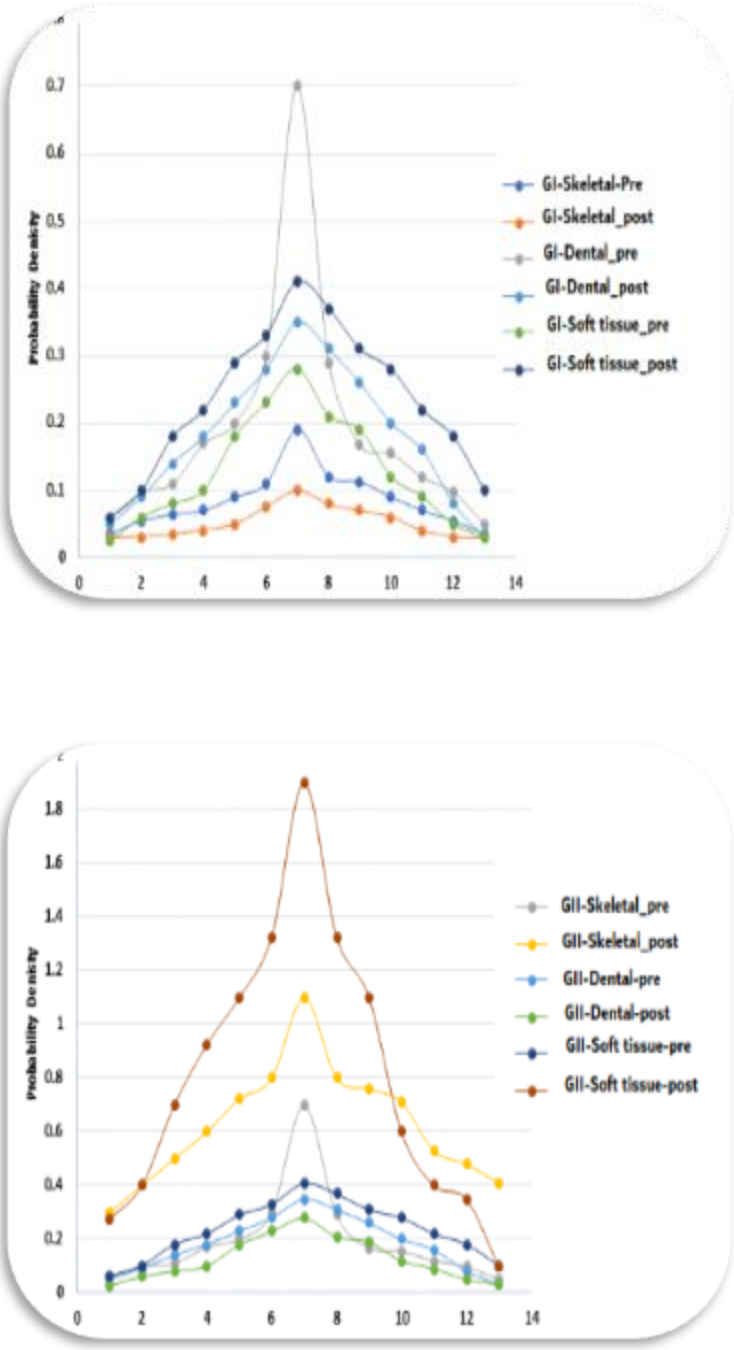

Figure (53): Scattered chart represents normal bell curve of normality test.

II. Baseline characterized:

1. Age:

In group I, minimum age was (18.4), maximum was (21.2), while mean ± standard deviation was (19.42 ± 1.03). In group II, minimum age was (18.08), maximum was (23.17), while mean ± standard deviation was (20.7 ± 2.24), as presented in table (12) and figure (54).

Comparison between both groups was performed by using Independent t-test which revealed insignificant difference between them as P >0.05, as presented in table (12).

Table (12): Minimum, maximum, mean & standard deviation of age in both groups:

	Min	Max	M	SD	P value
G I	18.4	21.2	19.42	1.03	0.09
G II	18.08	23.17	20.7	2.24	

N: count *Min: minimum* *Max: maximum*

M: mean *SD: standard deviation*

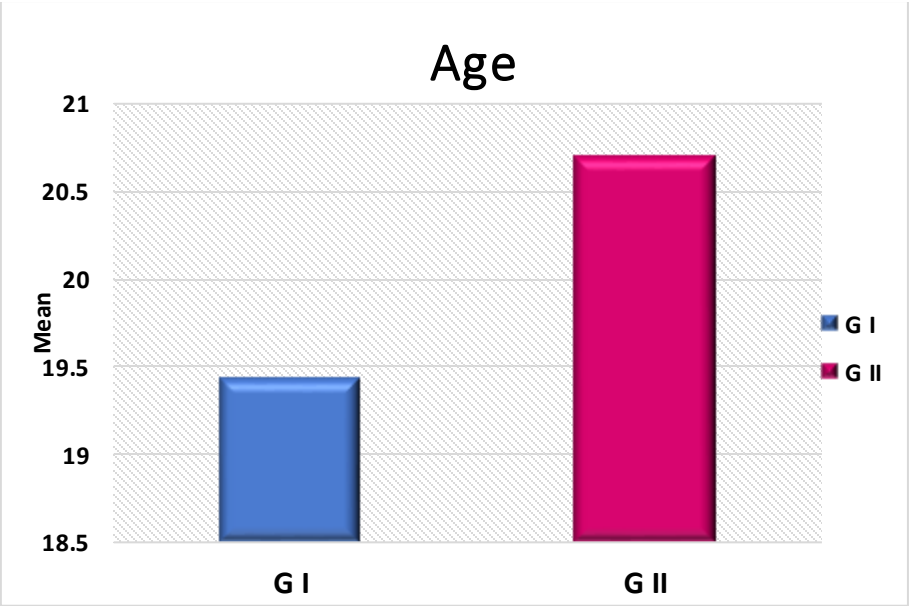

Figure (54): Bar chart showing mean of age in both groups.

2. Gender:

In gender all companions were performed by using Chi square test. In group I, male (16.67%) was significantly lower than female (83.3%) as $P < 0.05$, while in group II male (33.3%) was insignificantly lower than female (66.6%) as $P > 0.05$, as presented in table (13) and figure (55).

Also, comparison between group I & II reveled insignificant difference between them in both male & female as $P > 0.05$ as presented in table (13).

Table (13): Frequency & percentage of gender distribution in both groups:

Group	Male		Female		P value
	N	%	N	%	
Group I	2	16.67%	10	83.33%	0.001*
Group II	3	33.33%	6	66.67%	0.13
P value	0.34		0.34		

N: count %: percentage

P: probability level which is significant at P ≤ 0.05

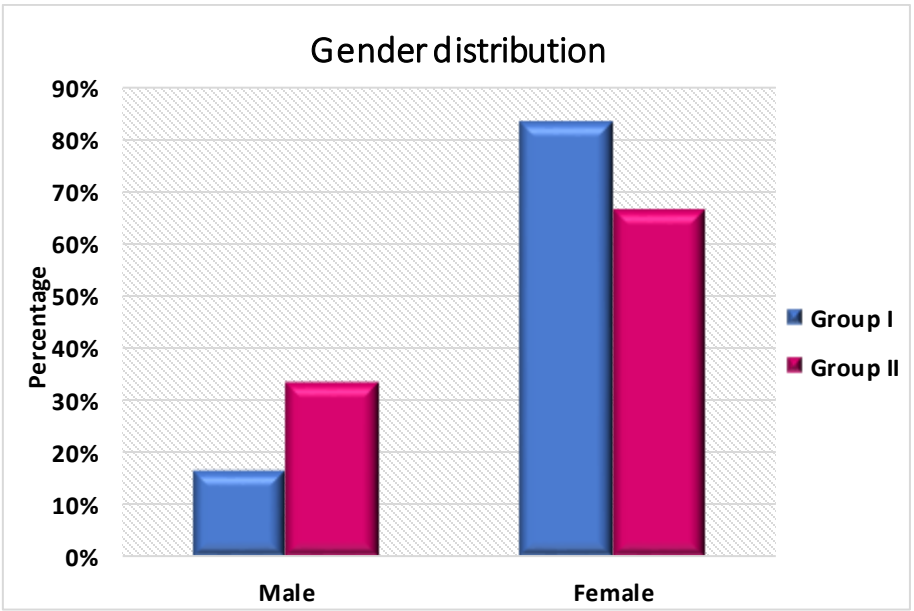

Figure (55): Bar chart showing percentage of gender distribution in both groups

3. Duration:

In group I, minimum duration was (5.5 months), maximum was (9.73 months), while mean ± standard deviation was (8.03 ± 2.9). In group II, minimum duration was (4 moths), maximum was (14.9 months), while mean ± standard deviation was (10.59 ± 3.89).

Comparison between both groups was performed by using Independent t-test which revealed insignificant difference between them as P>0.05, as presented in table (14) and figure (56).

Table (14): Minimum, maximum, mean & standard deviation of duration in months in both groups:

	Min	Max	M	SD	P value
Group I	**5.50**	**9.73**	**8.03**	**2.90**	**0.09**
Group II	**4.00**	**14.90**	**10.59**	**3.89**	

M: mean SD: standard deviation

P: probability level which is significant at P ≤ 0.05

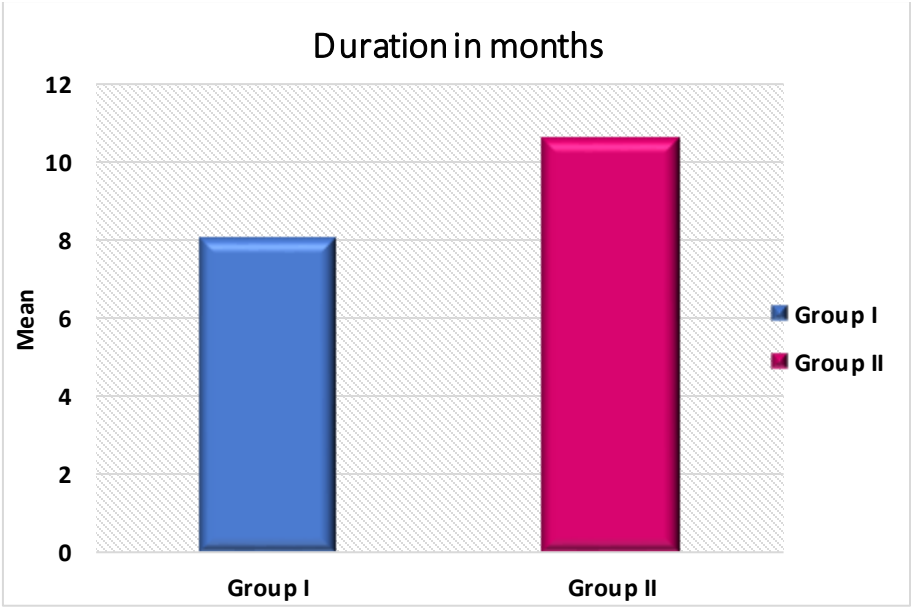

Figure (56): Bar chart showing mean of duration in months in both groups.

III. Measurements:

A. Skeletal:

1. Anteroposterior:

- **Group I:**

In group I pretreatment records, post treatment records and difference between them regarding anteroposterior skeletal measurements were presented in table (15) and figure (57).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as P >0.05, as presented in table (15).

Table (15): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding anteroposterior skeletal measurements in group I:

Group I Anteroposterior Skeletal Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	M	SD	
SNA angle	83.41	4.33	83.47	3.90	0.05	1.26	0.854
SNB angle	77.98	3.18	77.44	2.53	-0.54	1.36	0.194
ANB angle	5.50	2.11	6.07	2.53	0.57	1.72	0.273
A-NV distance	6.79	4.69	6.96	3.87	0.17	1.11	0.611
Pog-NV distance	6.06	6.44	6.02	5.32	-0.04	2.20	0.951

M: mean SD: standard deviation

P: probability level which is significant at $P \leq 0.05$

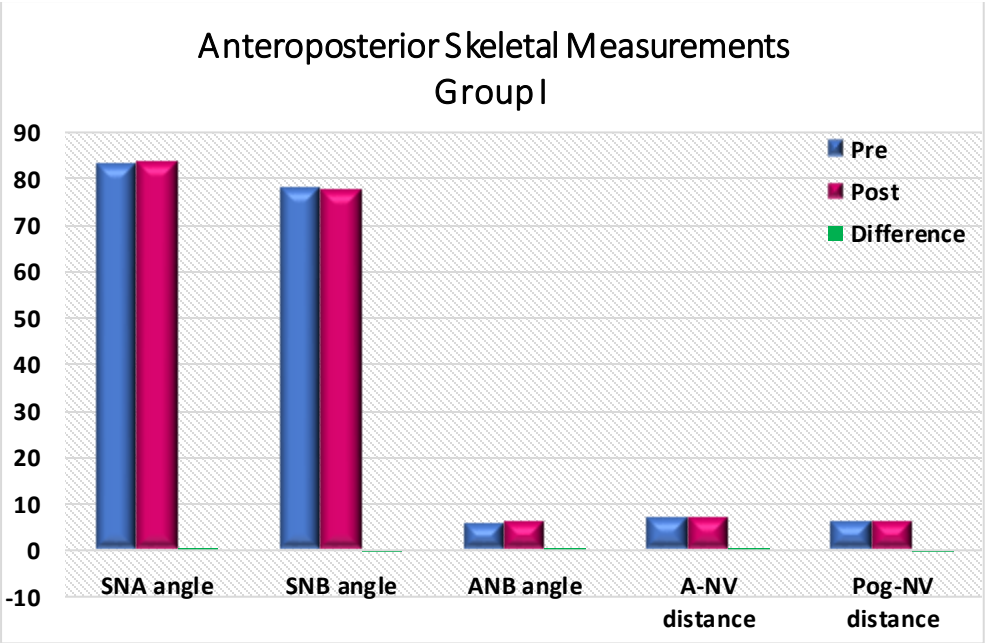

Figure (57): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding anteroposterior skeletal measurements in group I.

- **Group II:**

In group II pretreatment records, post treatment records and difference between them regarding anteroposterior skeletal measurements were presented in table (16) and figure (58).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as P >0.05, as presented in table (16).

Table (16): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding anteroposterior skeletal measurements in group II:

Group II Anteroposterior Skeletal Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	M	SD	
SNA angle	83.64	4.14	83.62	4.15	-0.02	1.07	0.952
SNB angle	79.27	3.08	79.13	3.03	-0.14	1.24	0.735
ANB angle	4.36	1.72	4.49	1.63	0.12	0.54	0.517
A-NV distance	7.44	3.13	7.09	3.00	-0.35	0.74	0.195
Pog-NV distance	8.10	3.71	7.31	3.26	-0.79	2.04	0.277

M: mean SD: standard deviation

P: probability level which is significant at $P \leq 0.05$

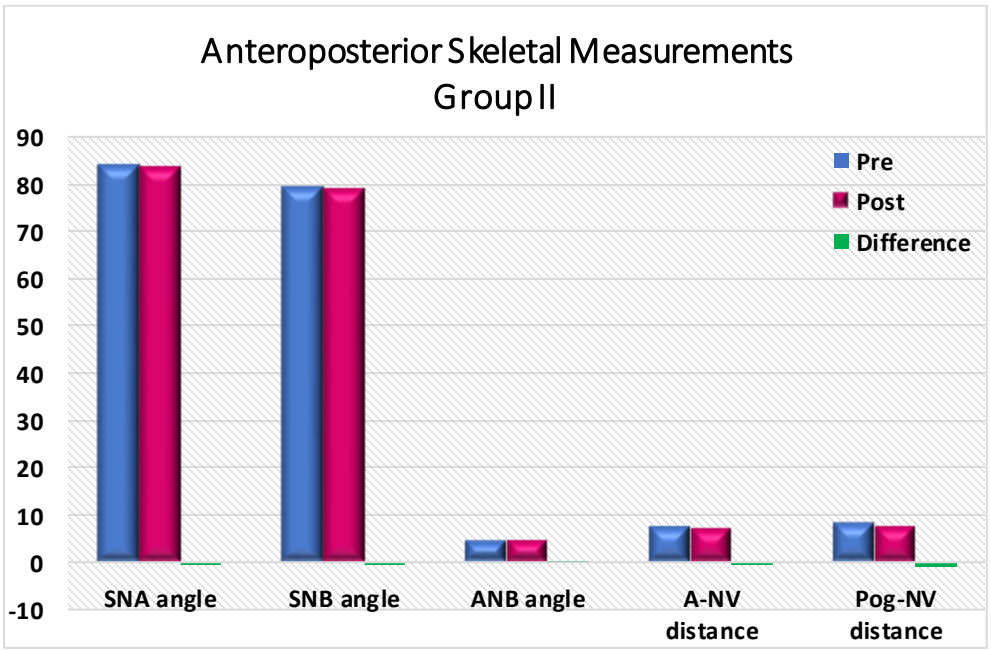

Figure (58): Bar chart showing pretreatment, post treatment records and difference between them regarding anteroposterior skeletal measurements in group II.

- **Comparison between both groups:**

Comparison between group I & II regarding difference between pretreatment & posttreatment records of anteroposterior skeletal measurements was performed by using Mann Whitney test which revealed insignificant difference between them regarding all measurements, as presented in table (17) and figure (59).

Table (17): Comparison between both groups regarding anteroposterior skeletal measurements:

Difference Anteroposterior Skeletal Measurements	Group I		Group II		P value
	MD	SD	MD	SD	
SNA angle	0.05	1.26	-0.02	1.07	0.81
SNB angle	-0.54	1.36	-0.14	1.24	0.75
ANB angle	0.57	1.72	0.12	0.54	0.75
A-NV distance	0.17	1.11	-0.35	0.74	0.24
Pog-NV distance	-0.04	2.20	-0.79	2.04	0.11

MD: mean difference SD: standard deviation

P: probability level which is significant at $P \leq 0.05$

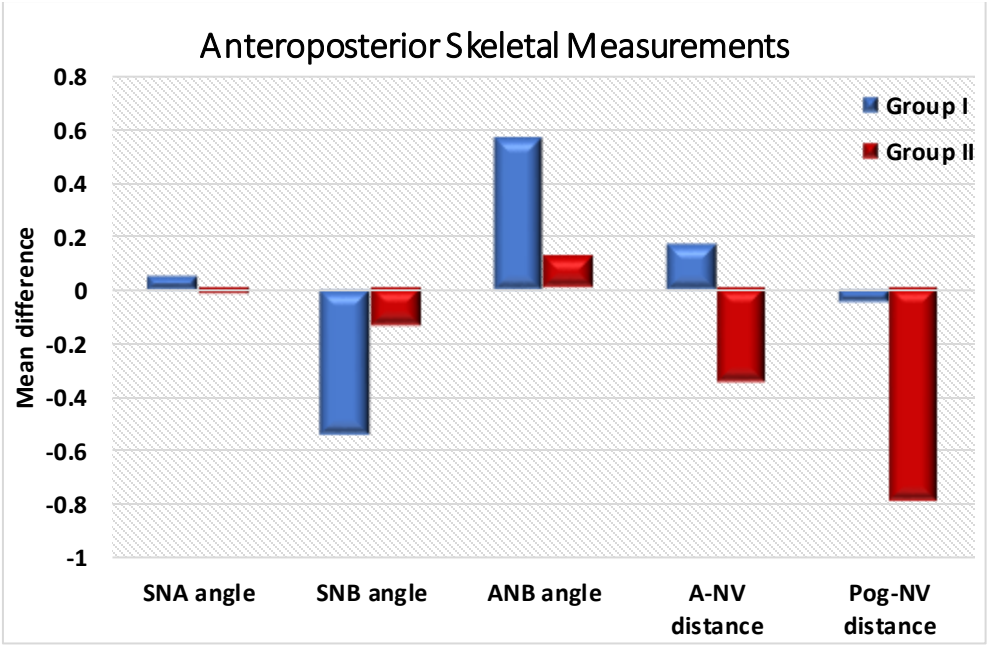

Figure (59): Bar chart showing comparison between both groups regarding anteroposterior skeletal measurements.

2. Vertical:

- **Group I:**

In group I pretreatment records, post treatment records and difference between them regarding vertical skeletal measurements were presented in table (18) and figure (60).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as P >0.05, as presented in table (18).

Table (18): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding vertical skeletal measurements in group I:

Group I Vertical Skeletal Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
PP-SN angle	8.66	3.09	8.96	3.81	0.31	0.91	0.425
ANS-Me distance	63.77	4.78	63.81	5.66	0.04	1.43	0.924
MP-SN angle	36.91	4.09	36.76	4.20	-0.15	0.61	0.265

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at P ≤ 0.05

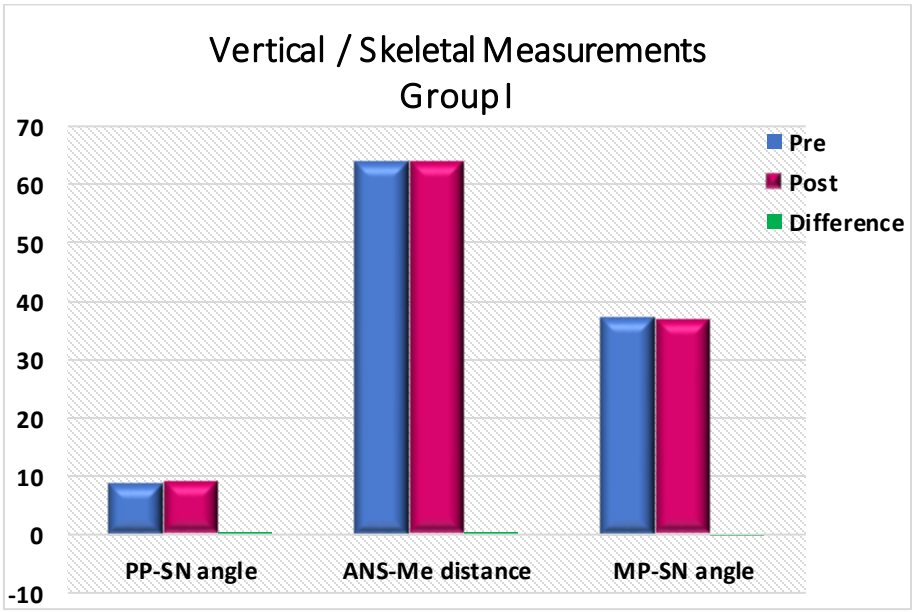

Figure (60): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding vertical skeletal measurements in group I.

- **Group II:**

In group II pretreatment records, post treatment records and difference between them regarding vertical skeletal measurements were presented in table (19) and figure (61).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as P >0.05, as presented in table (19).

Table (19): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding vertical skeletal measurements in group II:

Group II Vertical Skeletal Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
PP-SN angle	9.47	3.58	9.64	3.31	0.17	0.27	0.54
ANS-Me distance	65.55	4.86	65.04	5.93	-0.52	1.66	0.376
MP-SN angle	36.99	3.05	36.55	2.81	-0.44	1.40	0.377

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at P ≤ 0.05

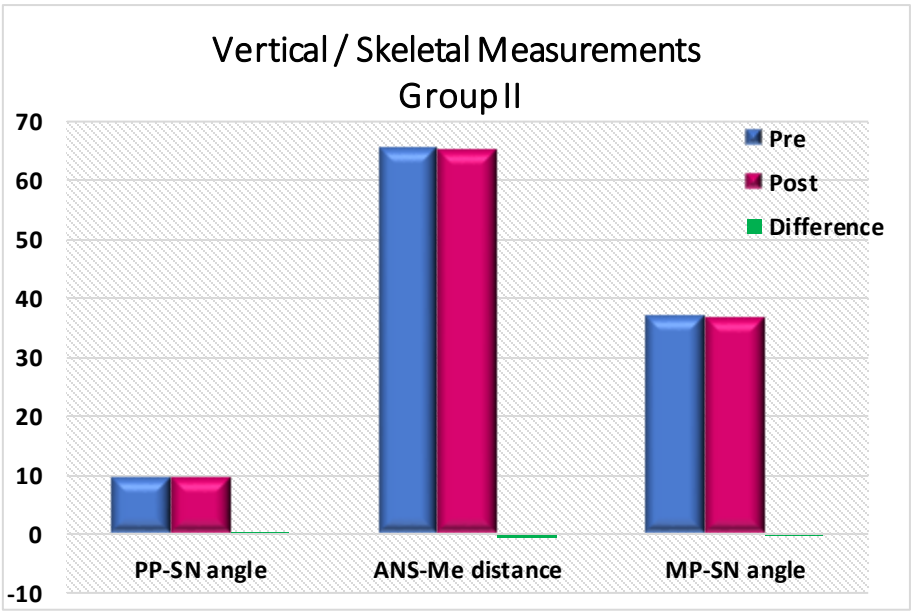

Figure (61): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding vertical skeletal measurements in group II.

- **Comparison between both groups:**

Comparison between group I & II regarding difference between pretreatment & posttreatment records of vertical skeletal measurements was performed by using Mann Whitney test which revealed insignificant difference between them regarding all measurements, as presented in table (20) and figure (62).

Table (20): Comparison between both groups regarding vertical skeletal measurements:

Difference Vertical Skeletal Measurements	Group I		Group II		P value
	MD	SD	MD	SD	
PP-SN angle	0.31	0.91	0.17	0.27	0.66
ANS-Me distance	0.04	1.43	-0.52	1.66	0.24
MP-SN angle	-0.15	0.61	-0.44	1.40	0.61

SD: standard deviation *MD: mean difference*

P: probability level which is significant at $P \leq 0.05$

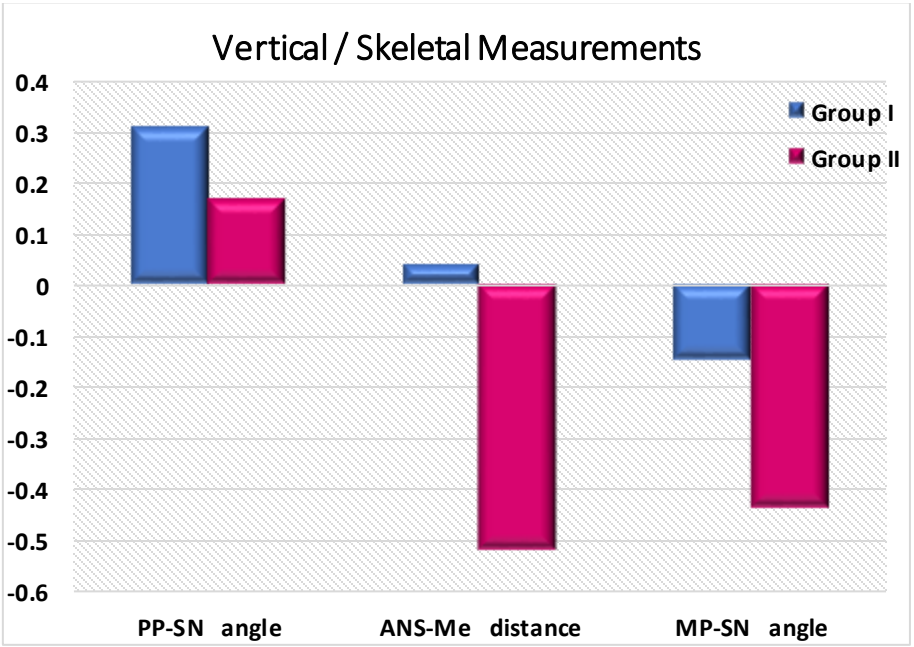

Figure (62): Bar chart showing comparison between both groups regarding vertical skeletal measurements.

B. Dental

1. Angular

a. Anteroposterior

- **Group I:**

In group I pretreatment records, post treatment records and difference between them regarding anteroposterior- angular- dental measurements were presented in table (21) and figure (63).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as $P > 0.05$ except U1-FHP and U5-FHP (Post was significantly higher than prerecord) as $P < 0.05$, as presented in table (21).

Table (21): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding anteroposterior angular dental measurements in group I:

Group I Anteroposterior Angular Dental Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
U1-NA	25.83	9.57	26.27	10.17	0.44	1.88	0.437
U1-FHP	123.54	12.59	124.50	12.88	0.97	1.46	0.042*
U4-FHP	102.14	9.64	103.24	11.70	1.10	4.80	0.444
U5-FHP	96.83	11.01	101.88	13.25	5.06	6.02	0.014*
U6-FHP	94.43	8.90	89.70	9.02	-4.72	9.69	0.119
U7-FHP	87.70	10.16	82.83	8.09	-4.87	8.16	0.063

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

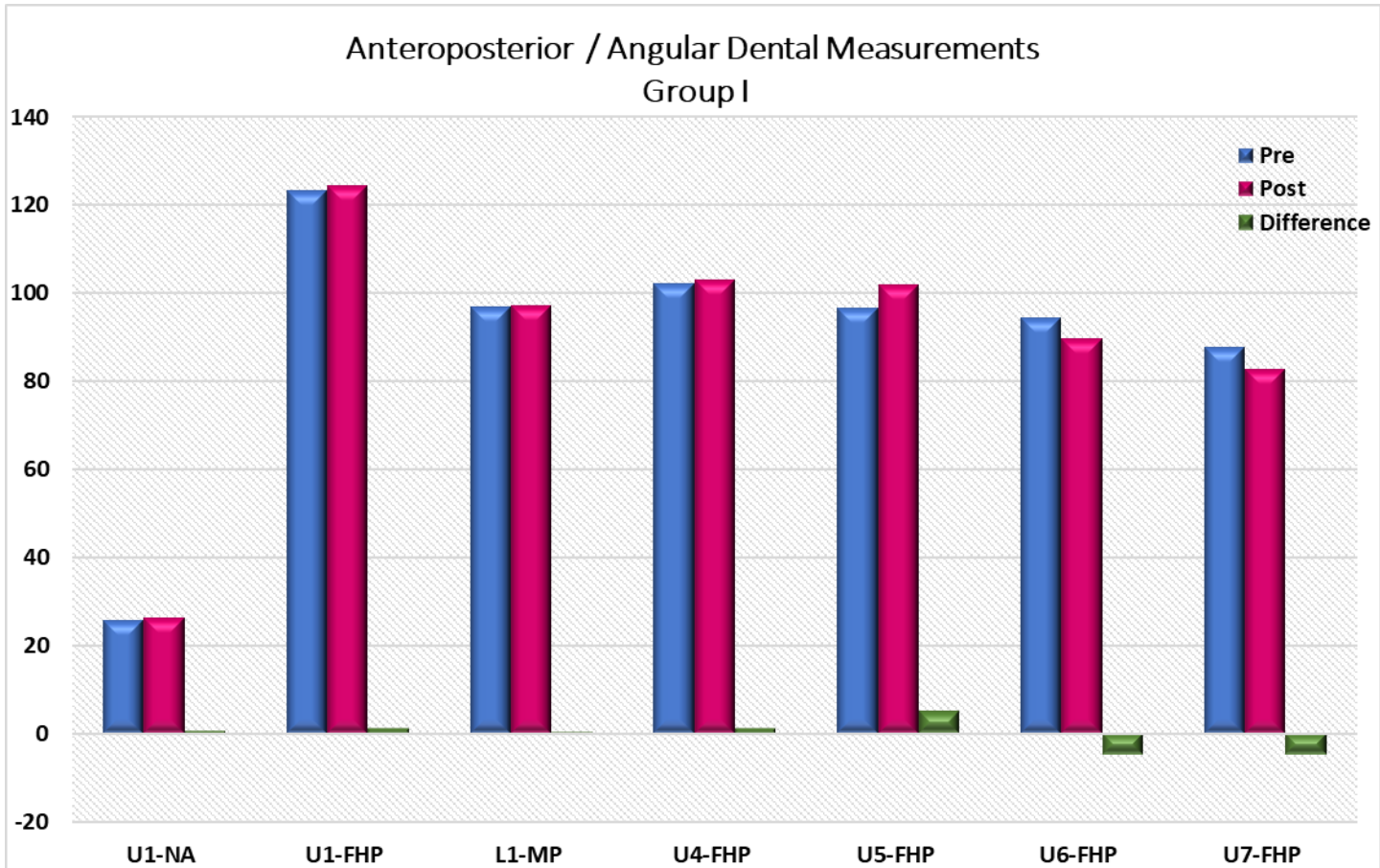

Figure (63): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding anteroposterior angular dental measurements in group I.

- **Group II:**

In group II pretreatment records, post treatment records and difference between them regarding anteroposterior- angular- dental measurements were presented in table (22) and figure (64).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as P >0.05 except U4-FHP and U5-FHP (Post records were significantly higher than prerecords), and U6-FHP (Post record was significantly lower than prerecord) as P < 0.05, as presented in table (22).

Table (22): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding anteroposterior angular dental measurements in group II:

Group II Anteroposterior Angular Dental Measurements	pre		post		Difference		P value
	M	SD	M	SD	MD	SD	
U1-NA	16.88	4.94	17.05	5.79	0.18	0.85	0.67
U1-FHP	114.61	4.00	115.05	4.83	0.43	0.83	0.44
U4-FHP	105.26	5.30	109.68	4.81	4.42	5.18	0.034*
U5-FHP	102.27	4.80	108.52	5.79	6.25	5.34	0.008*
U6-FHP	97.77	1.80	84.23	9.21	-13.54	8.61	0.002*
U7-FHP	88.47	8.81	80.17	9.62	-8.30	0.81	0.077

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at P ≤ 0.05

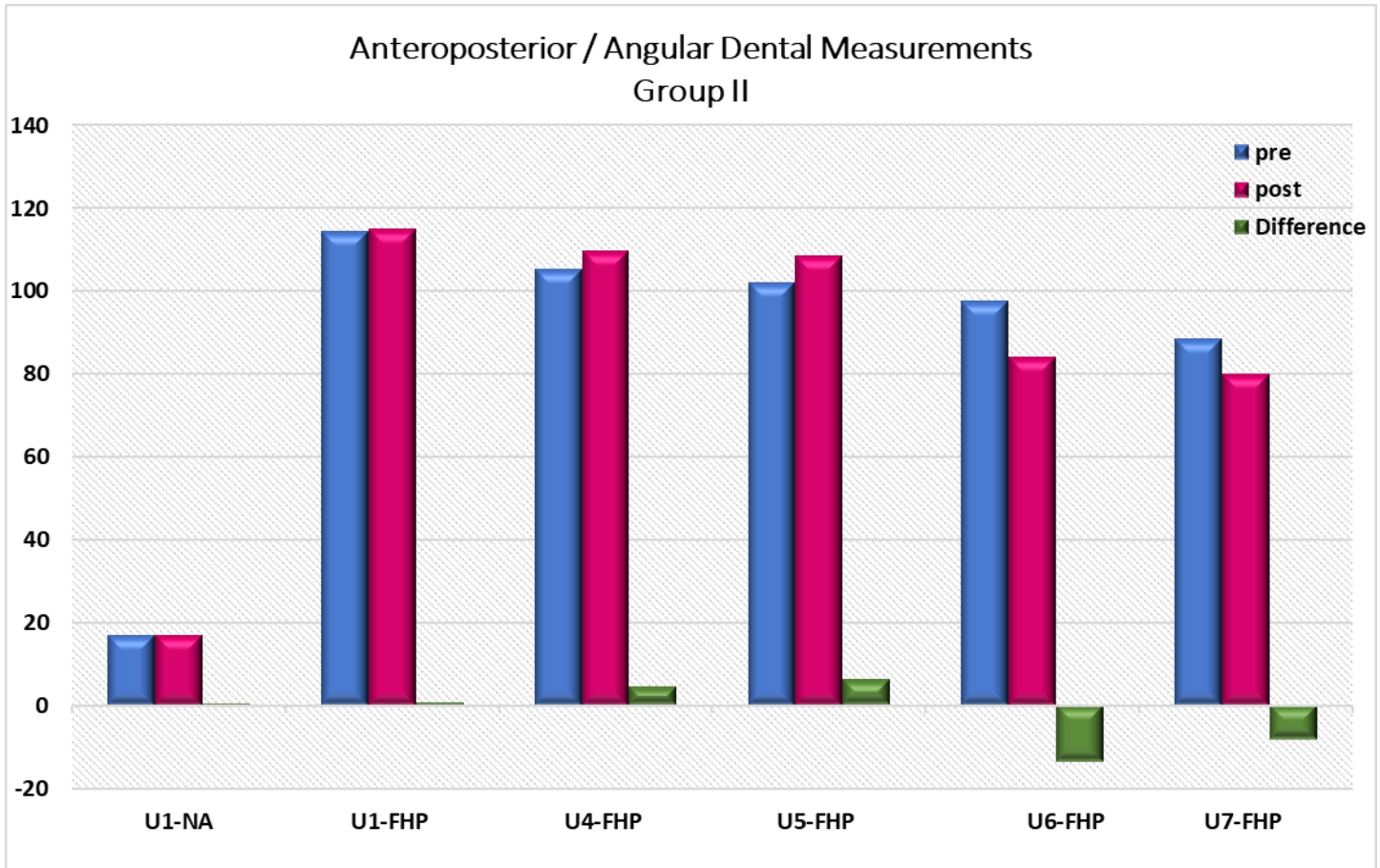

Figure (64): Bar chart showing pretreatment, post treatment records and difference between them regarding anteroposterior angular dental measurements in group II.

- **Comparison between both groups:**

Comparison between group I & II regarding difference between pretreatment & posttreatment records of anteroposterior angular dental measurements was performed by using Mann Whitney test which revealed insignificant difference between them regarding all measurements except U6-FHP (Group I was significantly higher than group II) as P <0.05, as presented in table (23) and figure (65).

Table (23): Comparison between both groups regarding anteroposterior angular dental measurements:

Difference Anteroposterior Angular Dental Measurements	Group I		Group II		P value
	MD	SD	MD	SD	
U1-NA	0.44	1.88	0.18	0.85	0.70
U1-FHP	0.97	1.46	0.43	0.83	0.33
U4-FHP	1.10	4.80	4.42	5.18	0.82
U5-FHP	5.06	6.02	6.25	5.34	0.61
U6-FHP	-4.72	9.69	-13.54	8.61	0.03*
U7-FHP	-4.87	8.16	-8.30	0.81	0.16

SD: standard deviation *MD: mean difference*

P: probability level which is significant at P ≤ 0.05

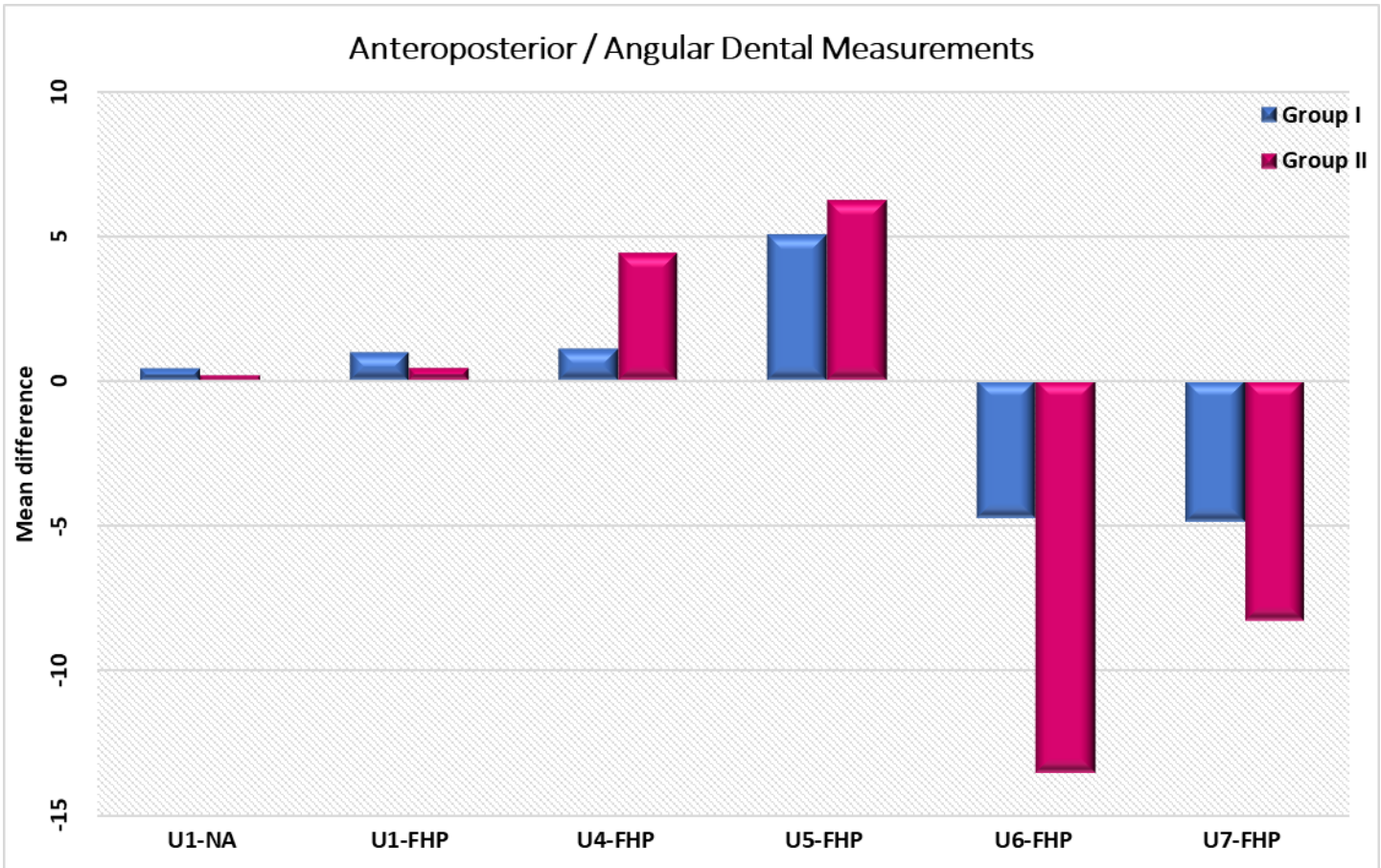

Figure (65): Bar chart showing comparison between both groups regarding anteroposterior angular dental measurements.

b. Rotation

- **Group I:**

In group I pretreatment records, post treatment records and difference between them regarding rotation- angular- dental measurements were presented in table (24) and figure (66).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as $P > 0.05$ except U5-MSP and U7-MSP as there was a statistical significant difference as $P < 0.05$ (Post was significantly higher than prerecord), while in U6-MSP there was a highly statistical significant difference as $P < 0.001$ (Post was significantly higher than prerecord) as presented in table (24).

Table (24): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding rotation angular dental measurements in group I:

Group I Rotation Angular Dental Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
U4-MSP	71.89	6.73	74.95	6.62	3.06	8.70	0.248
U5-MSP	68.84	7.63	63.36	7.23	-5.48	4.79	0.002*
U6-MSP	32.38	6.45	50.50	10.29	18.12	8.35	0.000**
U7-MSP	42.42	9.67	53.25	11.15	10.84	8.06	0.001*

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

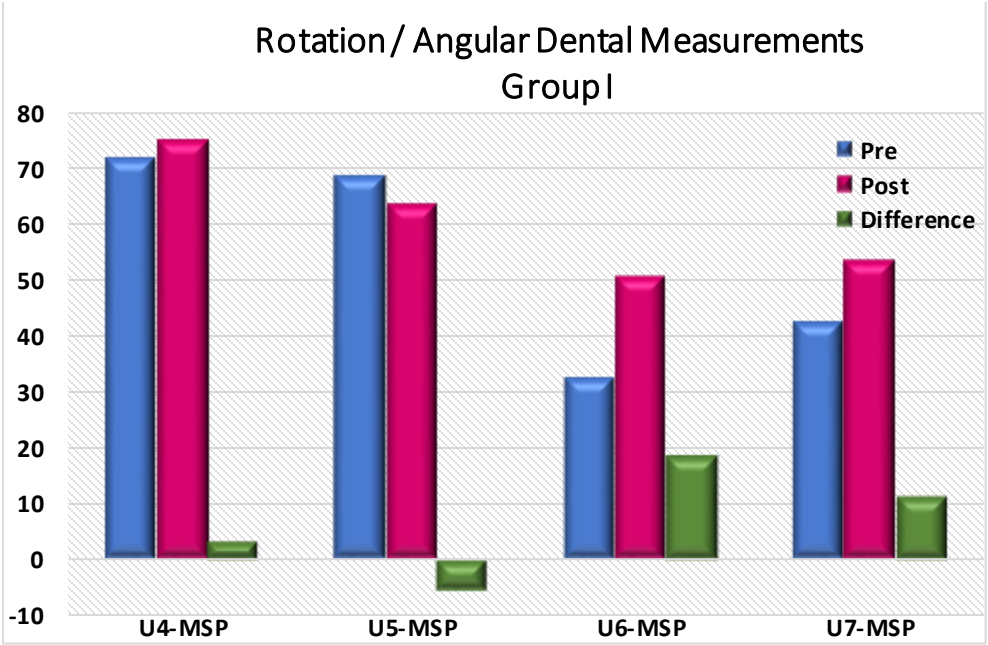

Figure (66): Bar chart showing pretreatment, post treatment records and difference between them regarding rotation angular dental measurements in group I.

- **Group II:**

In group II pretreatment records, post treatment records and difference between them regarding rotation- angular- dental measurements were presented in table (25) and figure (67).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as $P > 0.05$ except U5-MSP and U6-MSP as there was a statistical significant difference as $P < 0.05$ (Post was significantly higher than prerecord), as presented in table (25).

Table (25): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding rotation angular dental measurements in group II:

Group II Rotation Angular Dental Measurements	pre		post		Difference		P value
	M	SD	M	SD	MD	SD	
U4-MSP	74.75	5.74	75.51	7.01	0.76	7.22	0.761
U5-MSP	76.26	10.52	56.45	9.88	-19.81	11.69	0.001*
U6-MSP	32.33	6.82	51.46	19.53	19.13	19.26	0.018*
U7-MSP	37.63	6.55	64.09	13.42	26.47	6.87	0.057

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

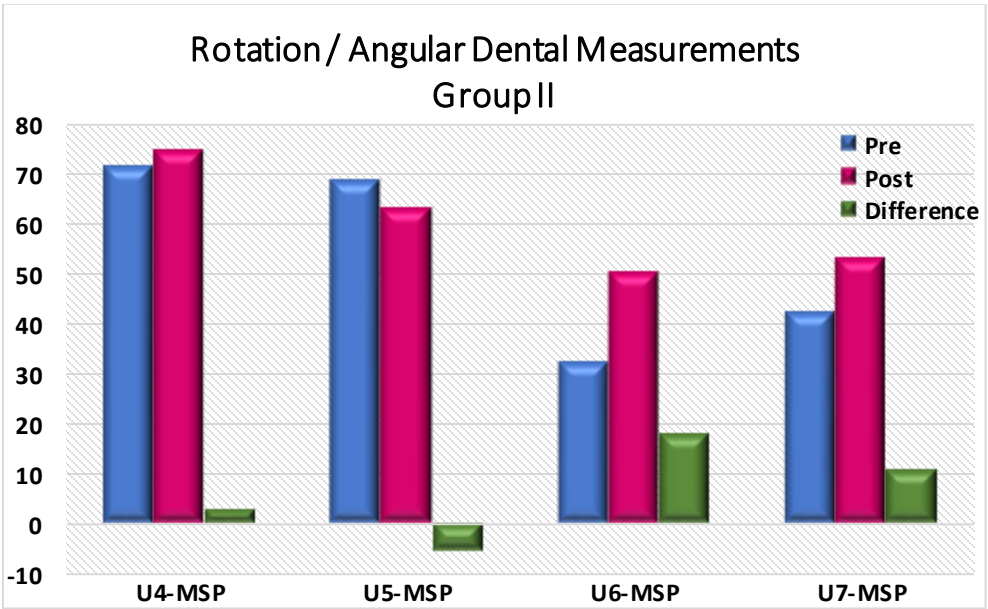

Figure (67): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding rotation angular dental measurements in group II.

- **Comparison between both groups:**

Comparison between group I & II regarding difference between pretreatment & posttreatment records of rotation - angular dental measurements was performed by using Mann Whitney test which revealed insignificant difference between them regarding all measurements except U5-MSP (Group I was significantly higher than group II) as P <0.05, as presented in table (26) and figure (68).

Table (26): Comparison between both groups regarding rotation angular dental measurements:

Difference Rotation Angular Dental Measurements	Group I		Group II		P value
	MD	SD	MD	SD	
U4-MSP	3.06	8.70	0.76	7.22	0.75
U5-MSP	-5.48	4.79	-19.81	11.69	0.009*
U6-MSP	18.12	8.35	19.13	19.26	0.45
U7-MSP	10.84	8.06	26.47	6.87	0.06

SD: standard deviation *MD: mean difference*

P: probability level which is significant at P ≤ 0.05

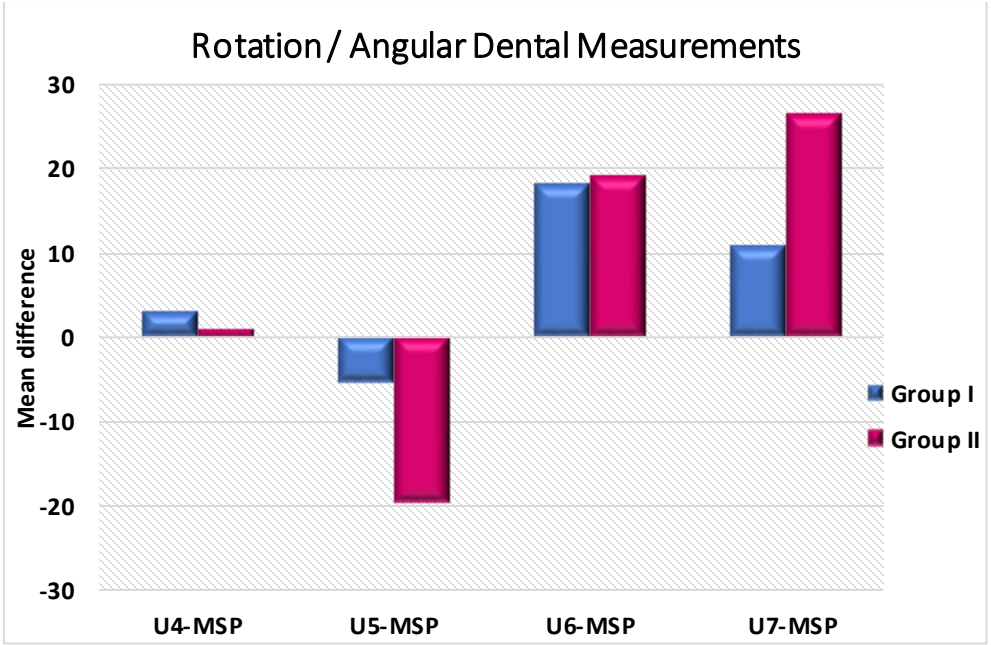

Figure (68): Bar chart showing comparison between both groups regarding rotation angular dental measurements.

c. Crown inclination

- **Group I:**

In group I pretreatment records, post treatment records and difference between them regarding crown inclination- angular- dental measurements were presented in table (27) and figure (69).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as $P > 0.05$ except U4 and U5 as there was a statistically significant difference as $P < 0.05$ (Post was significantly higher than prerecord), as presented in table (27).

Table (27): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding crown inclination - angular dental measurements in group I:

Group I Crown Inclination Angular Dental Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
U4	4.80	2.34	11.94	7.12	7.14	7.61	0.008*
U5	6.47	4.23	13.79	7.28	7.32	6.86	0.004*
U6	4.84	4.06	4.81	2.95	-0.03	3.87	0.980
U7	5.76	3.65	7.94	7.83	2.19	5.81	0.219

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at P ≤ 0.05

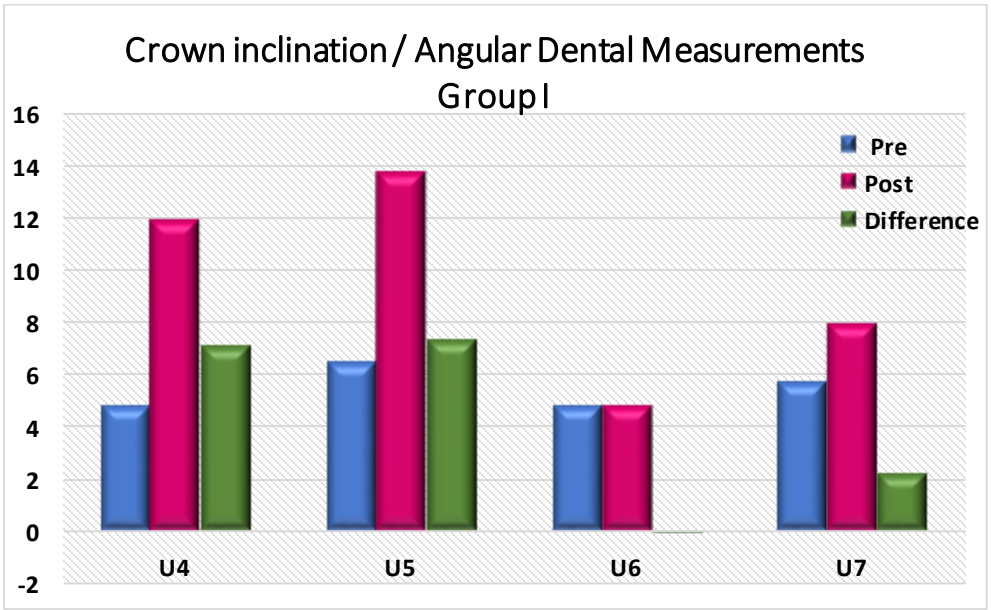

Figure (69): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding crown inclination - angular dental measurements in group I.

- **Group II:**

In group II pretreatment records, post treatment records and difference between them regarding crown inclination- angular- dental measurements were presented in table (28) and figure (70).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed significant difference between them in all measurements as P <0.05 except U5 as there was a statistical insignificant difference as P > 0.05 (Post was significantly higher than prerecord), as presented in table (28).

Table (28): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding crown inclination - angular dental measurements in group II:

Group II Crown Inclination Angular Dental Measurements	pre		post		Difference		P value
	M	SD	M	SD	MD	SD	
U4	5.11	3.82	12.77	6.01	7.66	7.31	0.014*
U5	8.28	5.27	14.25	7.50	5.98	8.45	0.067
U6	2.99	1.67	7.12	4.47	4.13	3.66	0.010*
U7	5.23	4.77	9.23	6.85	3.99	5.11	0.047*

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at P ≤ 0.05

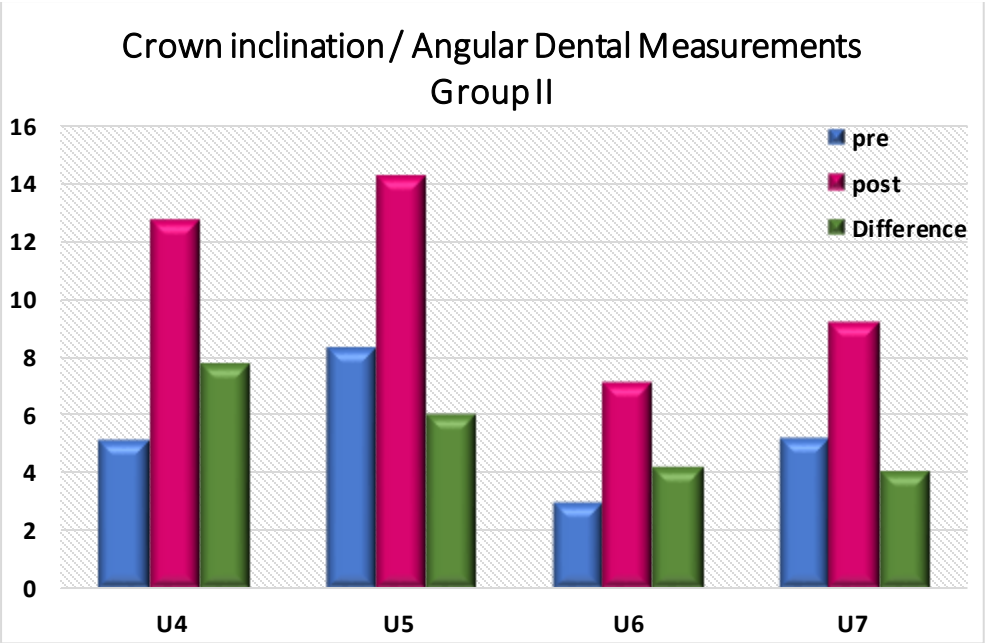

Figure (70): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding crown inclination - angular dental measurements in group II.

- **Comparison between both groups:**

Comparison between group I & II regarding difference between pretreatment & posttreatment records of crown inclination - angular dental measurements was performed by using Mann Whitney test which revealed insignificant difference between them regarding all measurements except U6 (Group I was significantly lower than group II) as $P < 0.05$, as presented in table (29) and figure (71).

Table (29): Comparison between both groups regarding crown inclination - angular dental measurements:

Difference Crown Inclination Angular Dental Measurements	Group I		Group II		P value
	MD	SD	MD	SD	
U4	7.14	7.61	7.66	7.31	0.86
U5	7.32	6.86	5.98	8.45	0.71
U6	-0.03	3.87	4.13	3.66	0.04*
U7	2.19	5.81	3.99	5.11	0.27

SD: standard deviation *MD: mean difference*

P: probability level which is significant at $P \leq 0.05$

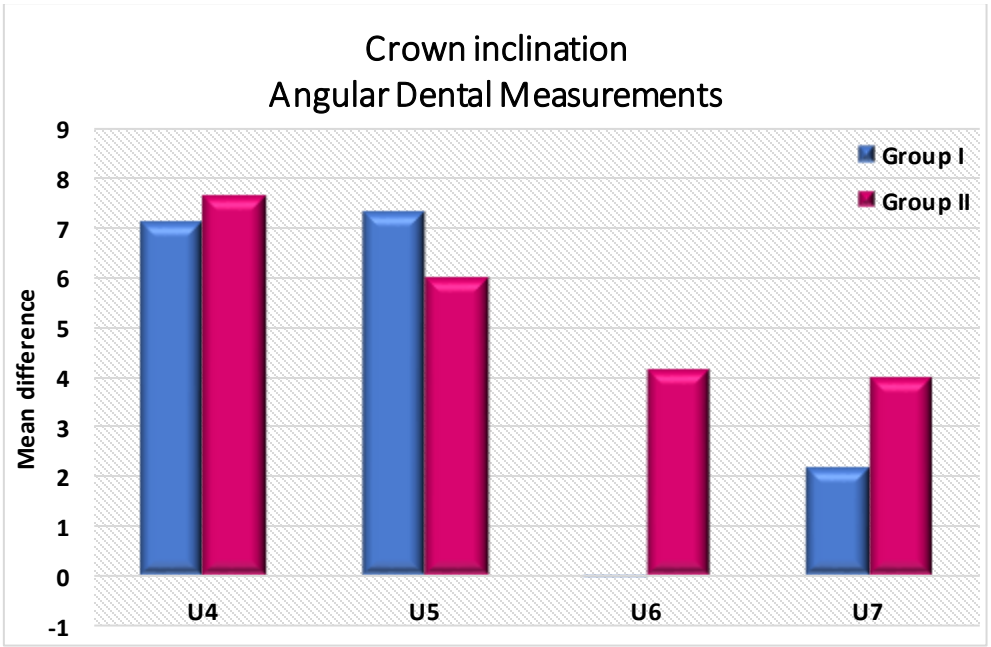

Figure (71): Bar chart showing comparison between both groups regarding crown inclination - angular dental measurement.

2. Linear

a. Anteroposterior

- **Group I:**

In group I pretreatment records, post treatment records and difference between them regarding anteroposterior- linear- dental measurements were presented in table (30) and figure (72). Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as $P > 0.05$ except U4-apex/S Ver and U5-apex/S Ver (Post was significantly higher than prerecord), MBc6/S Ver (Post was significantly lower than prerecord), as there was a statistical significant difference as $P < 0.05$, while in U5-tip/S Ver (Post was higher than pre),U6-apex/S Ver, MBc7/S Ver and U7-apex/S Ver (post was lower than pre) there was a highly statistical significant difference as $P < 0.0001$, as presented in table (30).

Table (30): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding anteroposterior - linear dental measurements in group I:

Group I Anteroposterior Linear Dental Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
U1-tip/S Ver	78.77	6.89	78.79	7.17	0.02	0.47	78.77
U1-apex/ S Ver	66.06	3.55	66.04	3.69	-0.02	1.21	0.861
L1-tip/S Ver	72.47	3.99	71.31	4.58	-1.16	2.50	0.948
U4-tip/S Ver	61.06	3.77	62.11	3.94	1.06	1.17	0.124
U4-apex/S Ver	57.08	3.56	59.67	3.11	2.59	1.64	0.010*
U5-tip/S Ver	54.68	3.61	56.08	3.71	1.40	1.00	0.000**
U5-apex/S Ver	52.57	2.51	54.42	2.71	1.86	1.55	0.001*
MBc6/S Ver	48.60	3.53	44.82	3.35	-3.78	1.31	0.002*
U6-apex/S Ver	47.70	3.06	44.92	2.83	-2.78	1.64	0.000**
MBc7/S Ver	37.47	3.57	34.21	3.32	-3.26	1.55	0.000**
U7-apex/S Ver	37.79	2.65	35.29	3.44	-2.50	2.45	0.000**
overjet	6.30	3.52	7.48	5.46	1.19	2.43	0.311

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

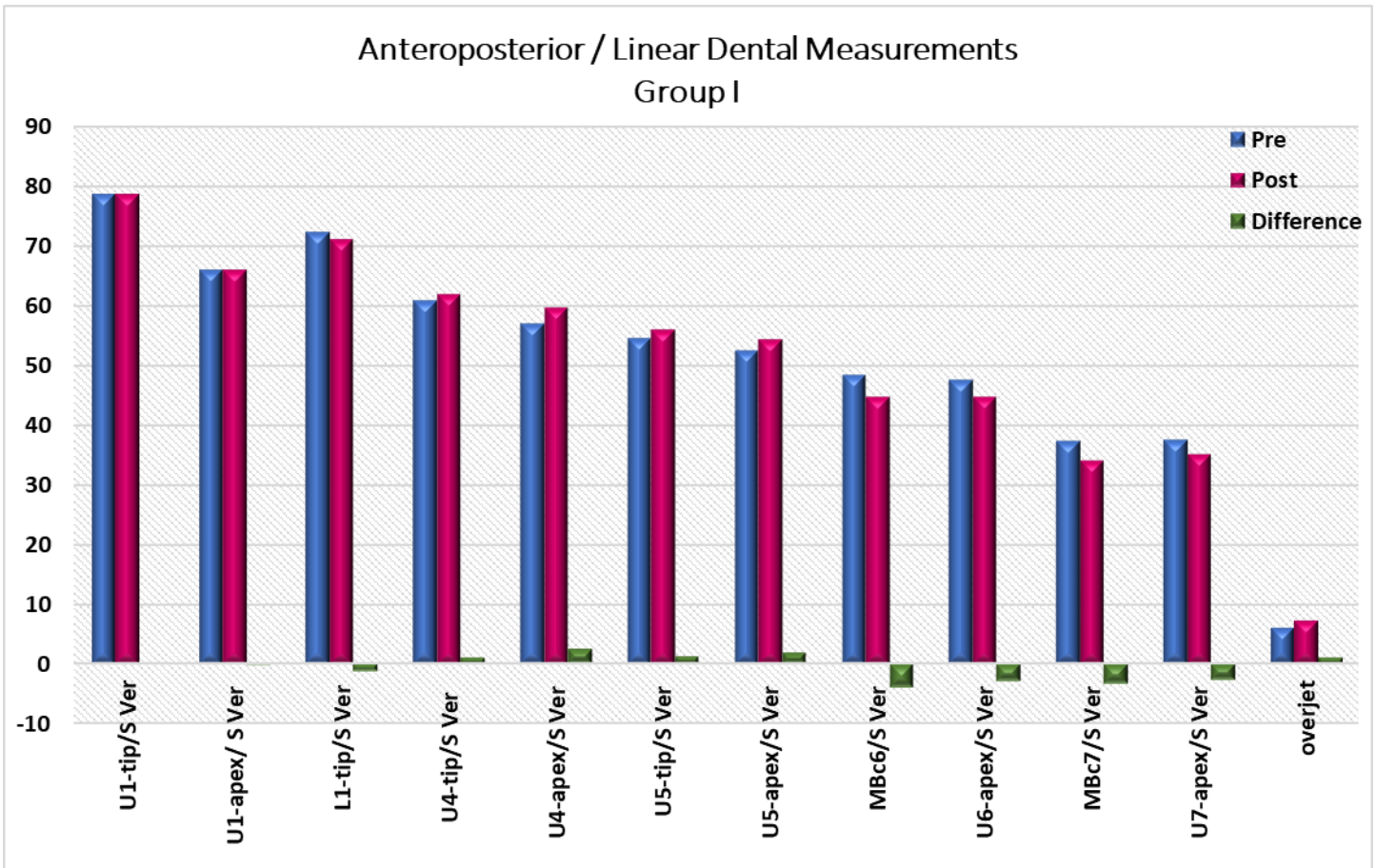

***Figure (72)*:** Bar chart showing mean of pretreatment, post treatment records and difference between them regarding anteroposterior - linear dental measurements in group I.

- **Group II:**

In group II pretreatment records, post treatment records and difference between them regarding anteroposterior- linear- dental measurements were presented in table (31) and figure (73).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as $P > 0.05$ except U4-apex/S Ver U5-tip/S Ver, U5-apex/S Ver (Post was significantly higher than prerecord and MBc6/S Ver , U6-apex/S Ver , MBc7/S Ver & U7-apex/S Ver (Post was significantly lower than prerecord), as there was a statistical significant difference as $P < 0.05$, , as presented in table (31).

Table (31): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding anteroposterior - linear dental measurements in group II:

Group II Anteroposterior Linear Dental Measurements	pre		post		Difference		P value
	M	SD	M	SD	MD	SD	
U1-tip/S Ver	76.89	2.86	77.48	2.99	0.59	0.13	0.12
U1-apex/ S Ver	67.13	3.09	67.56	3.18	0.43	0.08	0.25
L1-tip/S Ver	72.48	3.32	71.93	4.20	-0.54	1.61	0.342
U4-tip/S Ver	63.21	3.81	64.32	4.43	1.11	1.76	0.095
U4-apex/S Ver	57.90	3.53	59.69	2.68	1.79	1.19	0.002*
U5-tip/S Ver	56.43	3.58	58.31	3.87	1.88	1.49	0.005*
U5-apex/S Ver	53.48	2.83	54.85	2.27	1.37	1.58	0.031*
MBc6/S Ver	50.55	3.53	46.04	5.61	-4.51	3.39	0.004*
U6-apex/S Ver	48.06	3.97	45.94	5.17	-2.12	2.52	0.035*
MBc7/S Ver	39.93	3.98	34.61	5.39	-5.32	3.62	0.002*
U7-apex/S Ver	39.18	3.01	36.79	2.75	-2.40	0.98	0.000**
overjet	4.46	1.63	5.31	1.99	0.85	1.25	0.074

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

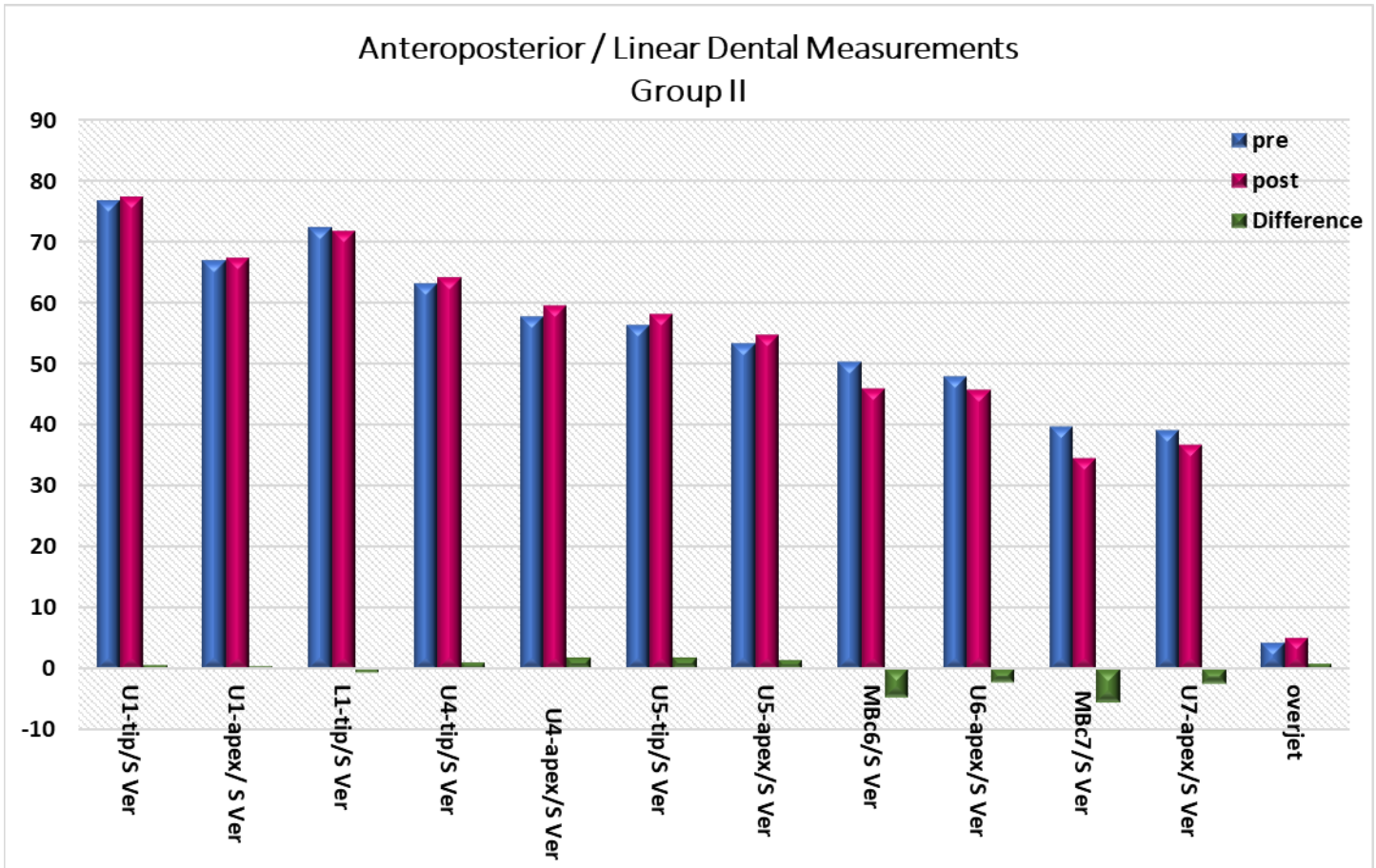

Figure (73): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding anteroposterior linear dental measurements *in group II.*

- **Comparison between both groups:**

Comparison between group I & II regarding difference between pretreatment & posttreatment records of anteroposterior - linear dental measurements was performed by using Mann Whitney test which revealed insignificant difference between them regarding all measurements except U1-tip/S Ver (Group I was significantly lower than group II) as $P < 0.05$, as presented in table (32) and figure (74).

Table (32): Comparison between both groups regarding anteroposterior - linear dental measurements:

Difference Anteroposterior Linear Dental Measurements	Group I		Group II		P value
	MD	SD	MD	SD	
U1-tip/S Ver	0.02	0.47	0.59	0.13	0.002*
U1-apex/ S Ver	-0.02	1.21	0.43	0.08	0.28
L1-tip/S Ver	-1.16	2.50	-0.54	1.61	1
U4-tip/S Ver	1.06	1.17	1.11	1.76	0.97
U4-apex/S Ver	2.59	1.64	1.79	1.19	0.31
U5-tip/S Ver	1.40	1.00	1.88	1.49	0.71
U5-apex/S Ver	1.86	1.55	1.37	1.58	0.71
MBc6/S Ver	-3.78	1.31	-4.51	3.39	0.8
U6-apex/S Ver	-2.78	1.64	-2.12	2.52	1
MBc7/S Ver	-3.26	1.55	-5.32	3.62	0.12
U7-apex/S Ver	-2.50	2.45	-2.40	0.98	0.86
overjet	1.19	2.43	0.85	1.25	0.75

SD: standard deviation *MD: mean difference*

P: probability level which is significant at $P \leq 0.05$

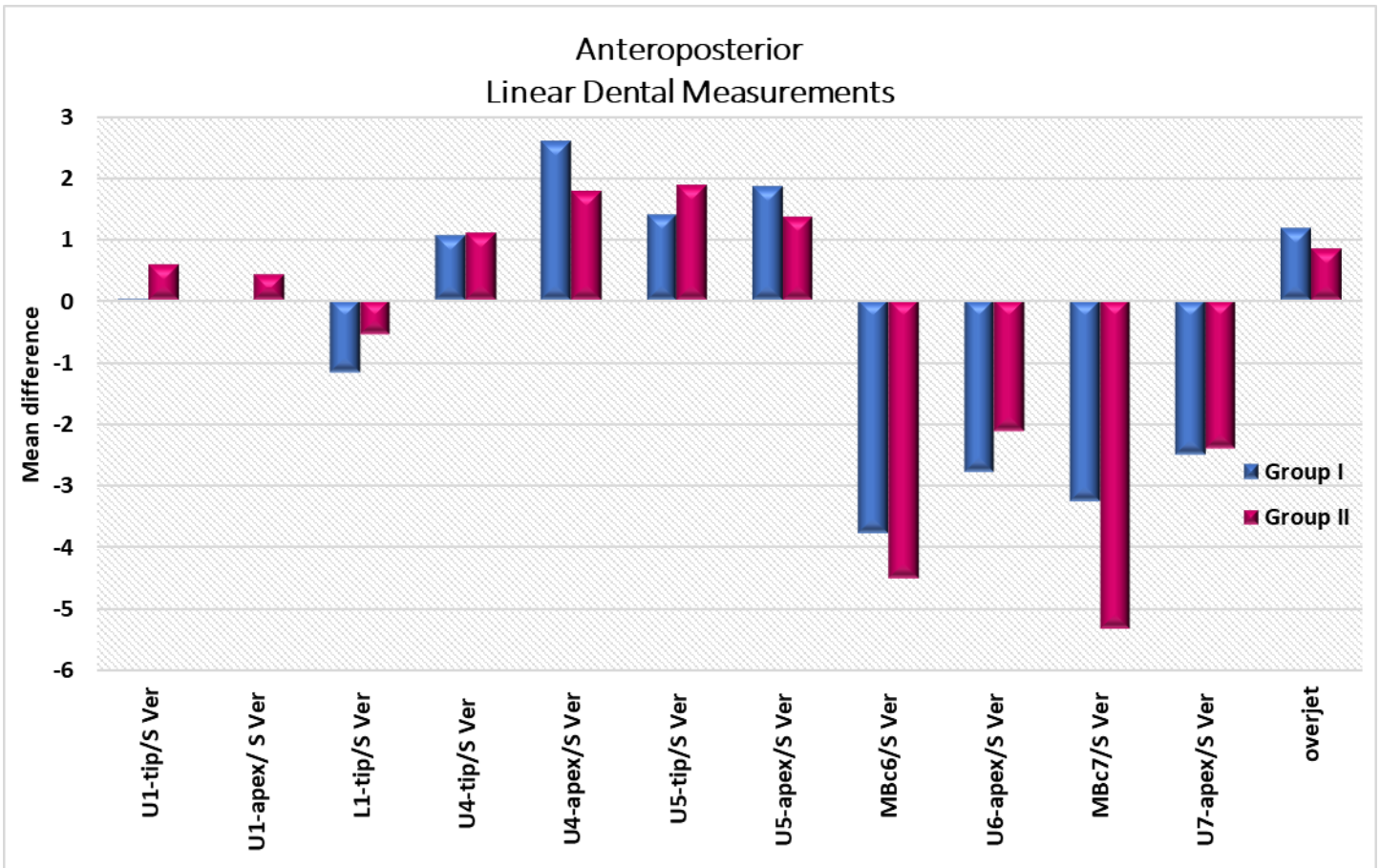

Figure (74): *Bar* chart showing comparison between both groups regarding anteroposterior - linear dental measurements.

b. Vertical

- **Group I:**

In group I pretreatment records, post treatment records and difference between them regarding vertical- linear- dental measurements were presented in table (33) and figure (75).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed significant difference between them in all measurements as $P < 0.05$ except overbite as there was insignificant difference between pre & post as $P > 0.05$. In U1-tip/PP, pre was significantly lower than post, while in U4-tip/PP, U5-tip/PP, MBc6/PP, MBc7/PP and L1-tip/PP pre was significantly higher than post as $P < 0.05$, as presented in table (33).

Table (33): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding vertical - linear dental measurements in group I:

Group I Vertical Linear Dental Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
U1-tip/PP	27.68	3.67	27.86	3.67	0.18	0.52	0.005*
U4-tip/PP	25.79	3.18	25.10	3.00	-0.69	0.56	0.001*
U5-tip/PP	25.25	2.82	24.56	3.01	-0.70	0.63	0.001*
MBc6/PP	23.90	2.50	22.75	2.75	-1.15	0.88	0.003*
MBc7/PP	21.43	2.81	20.77	3.24	-0.65	0.91	0.001*
L1-tip/PP	24.45	3.73	23.63	5.55	-0.82	2.67	0.008*
overbite	3.23	1.14	4.23	2.57	1.00	2.68	0.119

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

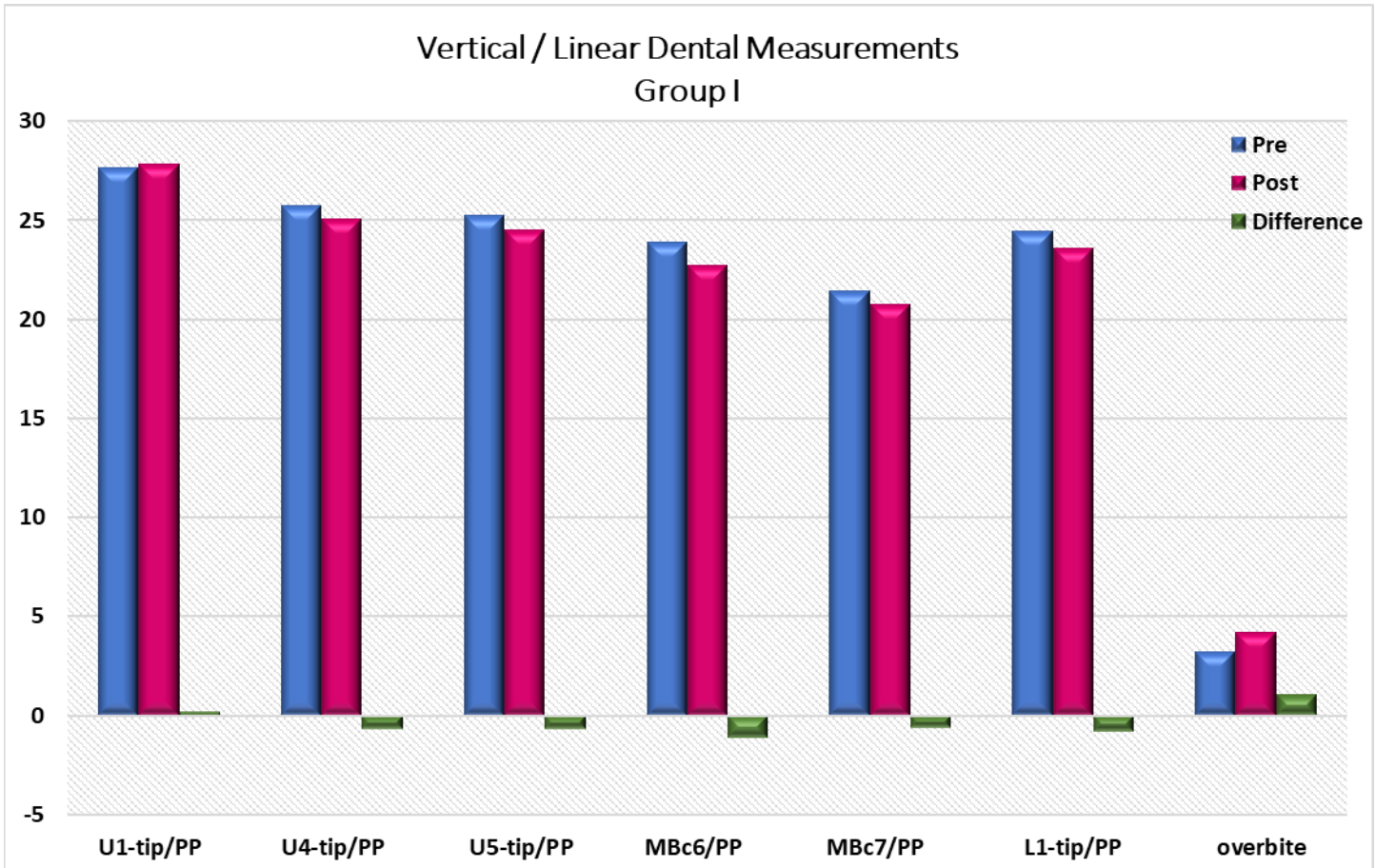

***Figure (75)*: Bar chart showing mean of pretreatment, post treatment records and difference between them regarding vertical linear dental measurements in group I.**

- **Group II:**

In group II pretreatment records, post treatment records and difference between them regarding vertical- linear- dental measurements were presented in table (34) and figure (76).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as P >0.05 except U4-tip/PP, MBc6/PP & MBc7/PP as Pre was significantly higher than post as P< 0.05., as presented in table (34).

Table (34): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding vertical - linear dental measurements in group II:

Group II Vertical Linear Dental Measurements	pre		post		Difference		P value
	M	SD	M	SD	M	SD	
U1-tip/PP	27.78	3.27	28.05	3.19	0.27	-0.09	0.16
U4-tip/PP	25.98	2.93	25.25	3.13	-0.73	0.86	0.036*
U5-tip/PP	25.21	3.05	24.76	3.62	-0.45	1.36	0.352
MBc6/PP	24.00	3.28	22.47	3.13	-1.53	1.21	0.005*
MBc7/PP	22.00	3.65	20.11	3.72	-1.88	1.83	0.015*
L1-tip/PP	24.74	4.08	24.18	4.37	-0.56	1.79	0.374
overbite	3.56	2.61	4.67	2.43	1.11	1.47	0.053

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at P ≤ 0.05

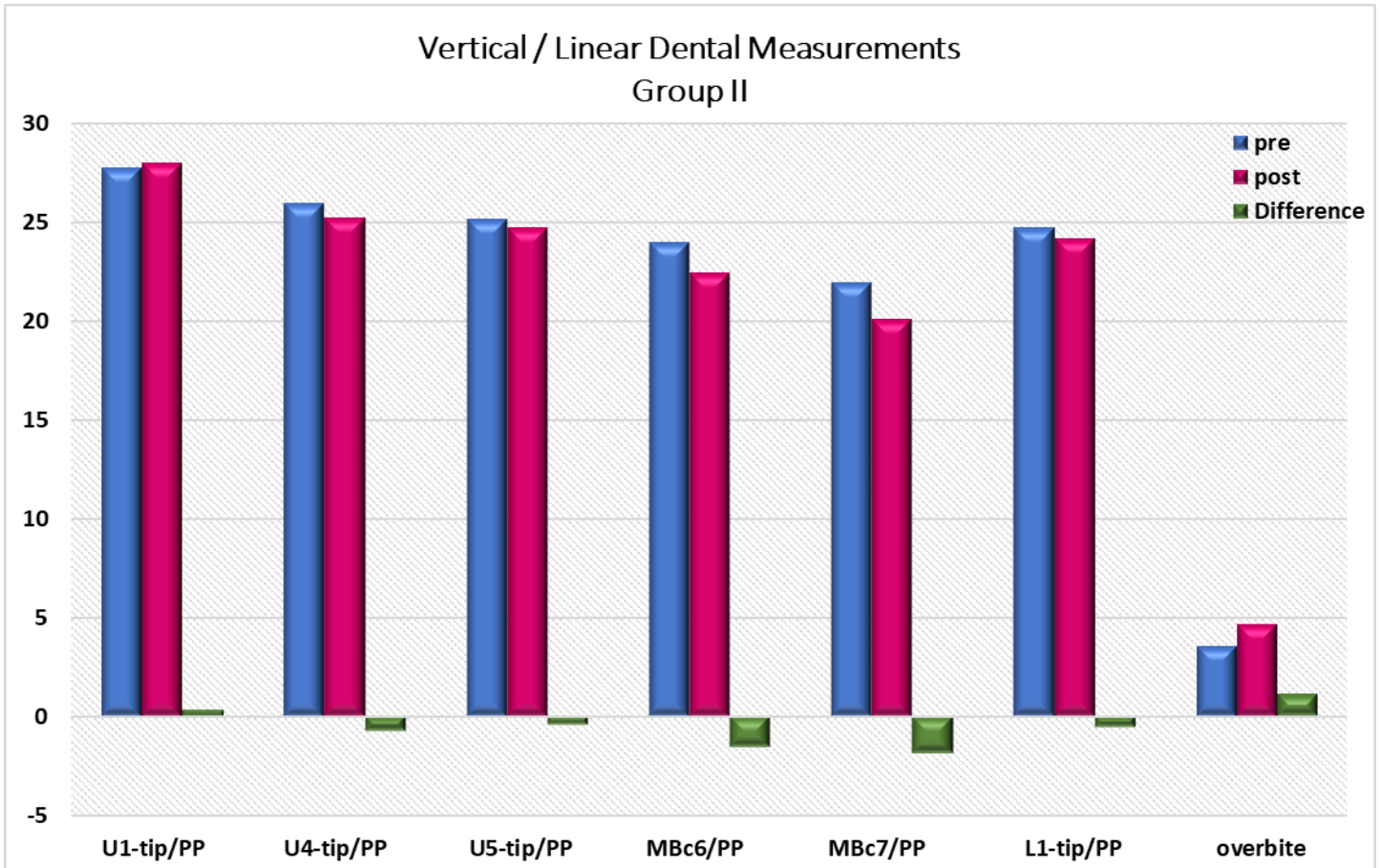

Figure (76): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding vertical linear dental measurements in group II.

- **Comparison between both groups:**

Comparison between group I & II regarding difference between pretreatment & posttreatment records of vertical - linear dental measurements was performed by using Mann Whitney test which revealed insignificant difference between them regarding all measurements, as presented in table (35) and figure (77).

Table (35): Comparison between both groups regarding vertical - linear dental measurements:

Difference Vertical Linear Dental Measurements	Group I		Group II		P value
	MD	SD	MD	SD	
U1-tip/PP	0.18	0.52	0.27	-0.09	0.61
U4-tip/PP	-0.69	0.56	-0.73	0.86	0.81
U5-tip/PP	-0.70	0.63	-0.45	1.36	0.86
MBc6/PP	-1.15	0.88	-1.53	1.21	0.81
MBc7/PP	-0.65	0.91	-1.88	1.83	0.11
L1-tip/PP	-0.82	2.67	-0.56	1.79	0.65
overbite	1.00	2.68	1.11	1.47	0.27

SD: standard deviation *MD: mean difference*

P: probability level which is significant at $P \leq 0.05$

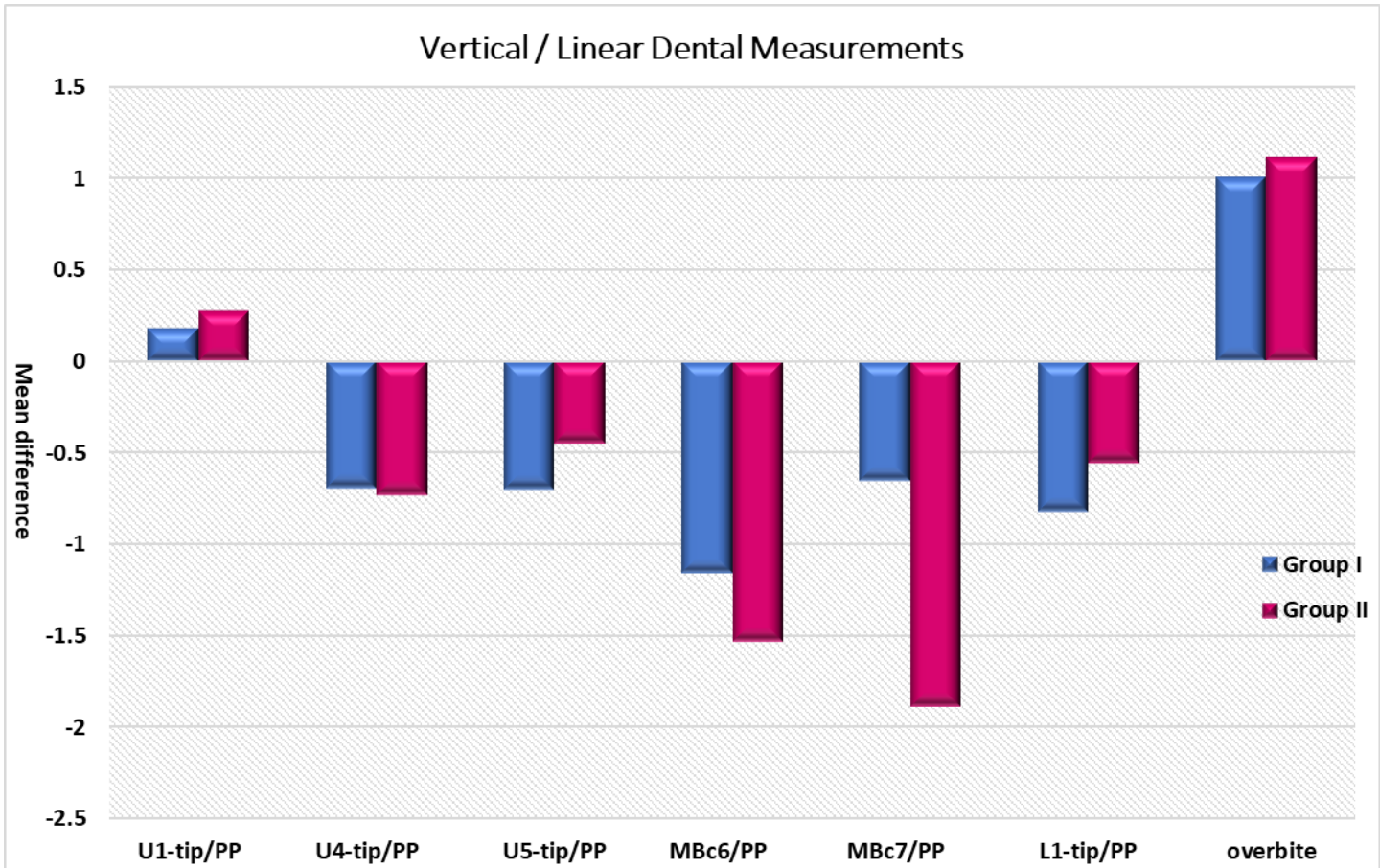

Figure (77): Bar chart showing comparison between both groups regarding vertical linear dental measurements

c. Transverse

- **Group I:**

In group I pretreatment records, post treatment records and difference between them regarding transverse- linear- dental measurements were presented in table (36) and figure (78).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed significant difference between them in all measurements as $P < 0.05$ except U4 as there was insignificant difference between pre & post as $P > 0.05$. In U5, there was a statistically significant difference as $P < 0.05$ (pre was significantly lower than post), while in U6 and U7 there was a highly statistical significant difference as $P < 0.001$ (pre was significantly lower than post), as presented in table (36).

Table (36): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding transverse - linear dental measurements in group I:

Group I Transverse Linear Dental Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
U4	16.80	2.01	18.55	2.03	1.75	1.36	0.438
U5	18.83	2.06	20.84	1.94	2.01	1.11	0.001*
U6	21.96	2.21	23.39	2.06	1.43	0.98	0.000**
U7	24.50	2.55	25.45	2.50	0.95	1.01	0.000**

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

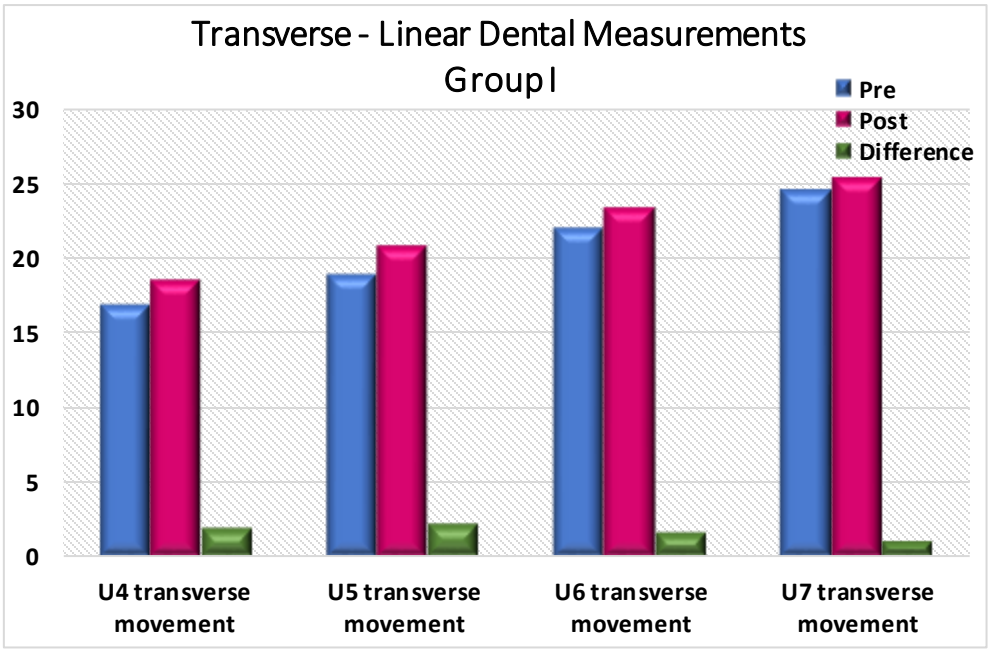

Figure (78): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding transverse - linear dental measurements in group I.

- **Group II:**

In group II pretreatment records, post treatment records and difference between them regarding transverse- linear- dental measurements were presented in table (37) and figure (79).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as $P < 0.05$, as presented in table (37).

Table (37): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding transverse - linear dental measurements in group II:

Group II Transverse Linear Dental Measurements	pre		post		Difference		P value
	M	SD	M	SD	M	SD	
U4	17.45	2.12	18.04	2.02	0.60	1.95	0.387
U5	20.04	1.82	20.80	2.00	0.76	1.59	0.188
U6	23.01	1.76	23.66	1.35	0.65	1.15	0.130
U7	25.04	2.14	25.06	1.80	0.02	2.30	0.984

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

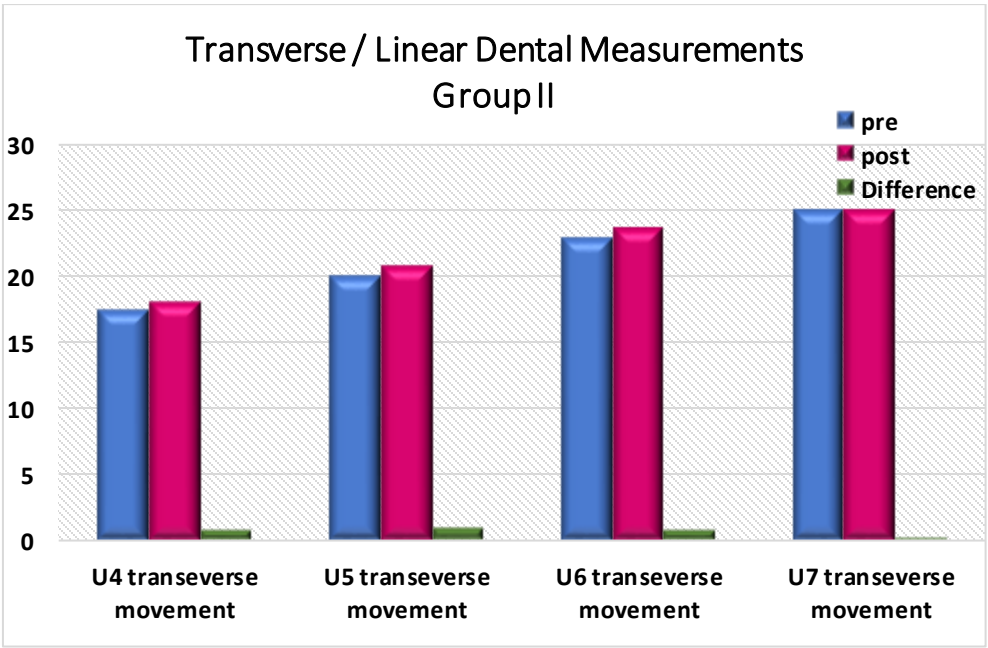

Figure (79): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding transverse - linear dental measurements in group II.

- **Comparison between both groups:**

Comparison between group I & II regarding difference between pretreatment & posttreatment records of transverse – linear dental measurements was performed by using Mann Whitney test which revealed insignificant difference between them regarding all measurements except U5 (Group I was significantly higher than group II) as P <0.05, as presented in table (38) and figure (80).

Table (38): Comparison between both groups regarding transverse - linear dental measurements:

Difference Transverse Linear Dental Measurements	Group I		Group II		P value
	MD	SD	MD	SD	
U4	1.75	1.36	0.60	1.95	0.19
U5	2.01	1.11	0.76	1.59	0.04*
U6	1.43	0.98	0.65	1.15	0.09
U7	0.95	1.01	0.02	2.30	0.31

SD: standard deviation *MD: mean difference*

P: probability level which is significant at P ≤ 0.05

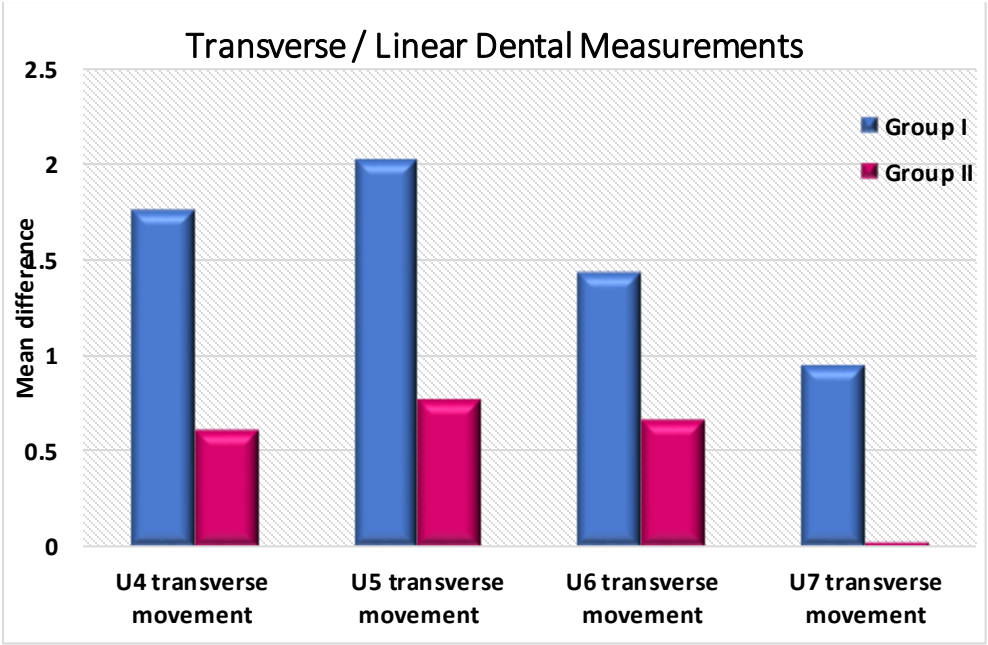

Figure (80): Bar chart showing comparison between both groups regarding transverse -linear dental measurements.

C. Soft tissue

- **Group I:**

In group I pretreatment records, post treatment records and difference between them regarding soft tissue measurements were presented in table (39) and figure (81,82).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as $P > 0.05$, as presented in table (39).

Table (39): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding soft tissue measurements in group I:

Group I Soft tissue Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
Ls/E-line distance	2.72	1.27	2.81	0.74	0.10	0.70	0.643
Li/E-line distance	2.40	1.58	2.05	1.46	-0.36	0.96	0.226
NLA angle	97.44	12.44	98.61	13.17	1.17	3.37	0.253

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

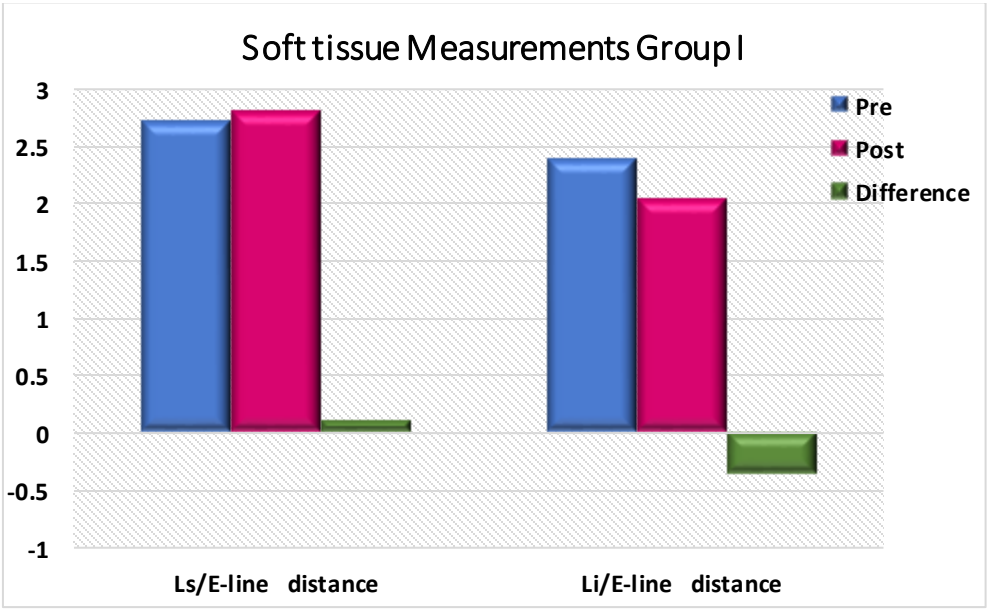

Figure (81): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding Ls/E-line distance & Li/E-line distance in group I.

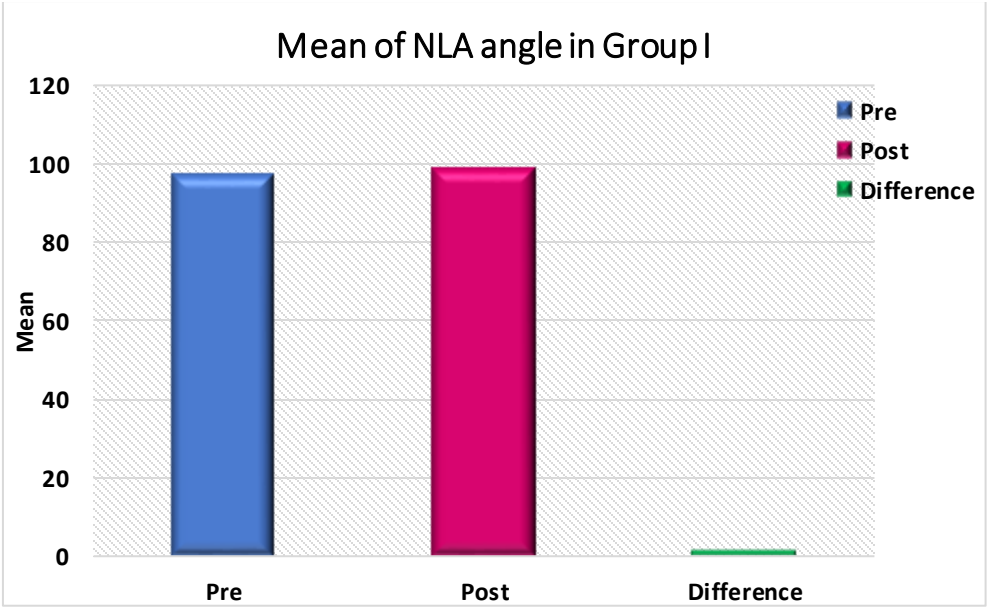

Figure (82): Bar chart showing Mean of pretreatment, post treatment records and difference between them regarding NLA angle in Group I.

- **Group II:**

In group II pretreatment records, post treatment records and difference between them regarding soft tissue measurements were presented in table (40) and figure (83,84).

Comparison between pretreatment & post treatment records was performed by using Paired t-test which revealed insignificant difference between them in all measurements as P >0.05, as presented in table (40).

Table (40): Mean & standard deviation of pretreatment, post treatment records and difference between them regarding soft tissue measurements in group II:

Group II Soft tissue Measurements	Pre		Post		Difference		P value
	M	SD	M	SD	MD	SD	
Ls/E-line distance	3.61	2.78	3.22	2.14	-0.40	2.34	0.625
Li/E-line distance	2.86	2.00	2.23	1.74	-0.63	2.13	0.403
NLA angle	105.30	9.52	105.91	6.47	0.61	3.98	0.656

M: mean SD: standard deviation MD: mean difference

P: probability level which is significant at $P \leq 0.05$

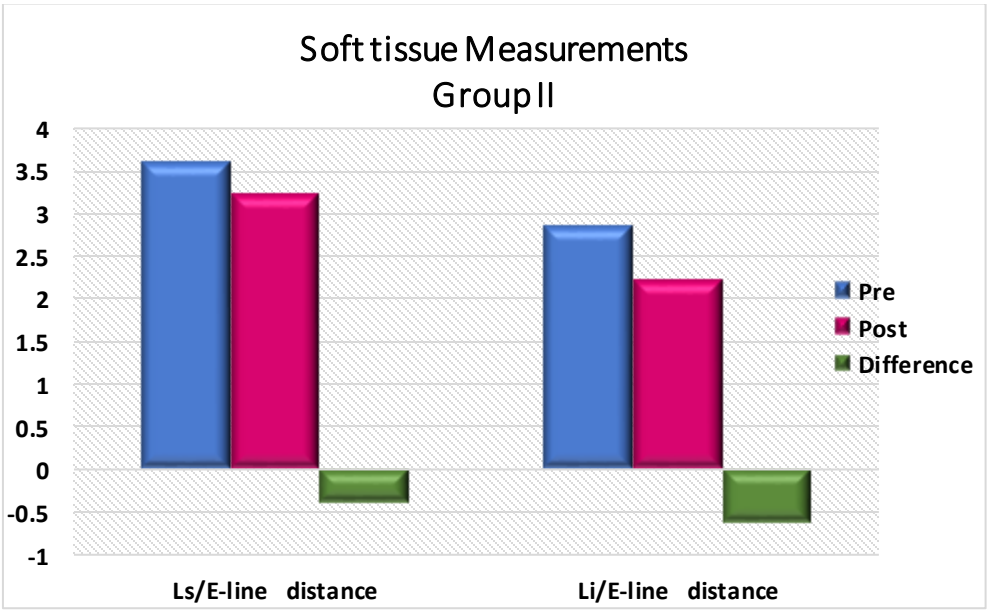

Figure (83): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding Ls/E-line distance & Li/E-line distance in group II.

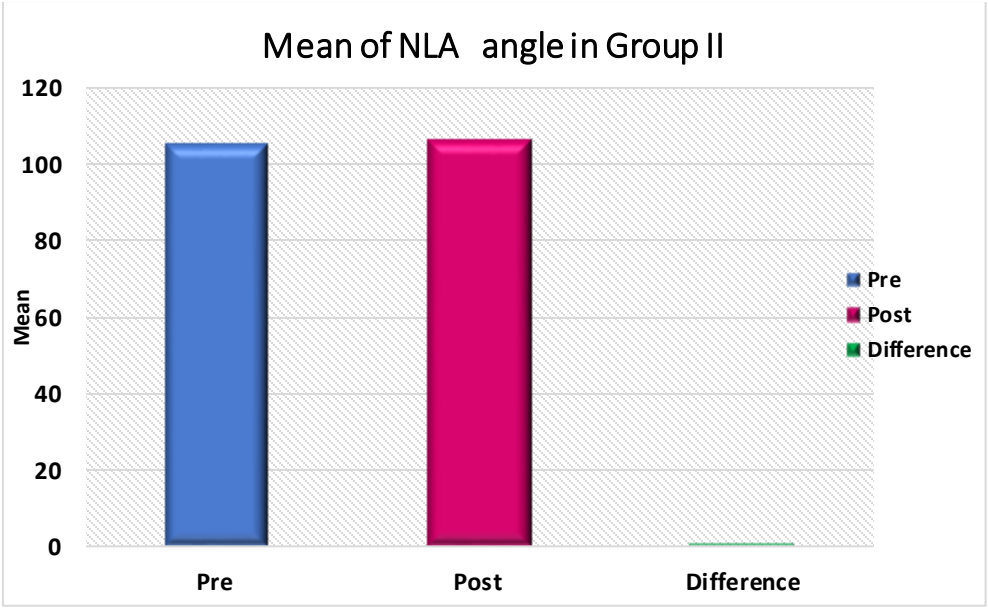

Figure (84): Bar chart showing mean of pretreatment, post treatment records and difference between them regarding Mean of NLA angle in Group II.

- **Comparison between both groups:**

Comparison between group I & II regarding difference between pretreatment & posttreatment records of soft tissue measurements was performed by using Mann Whitney test which revealed insignificant difference between them regarding all measurements, as presented in table (41) and figure (85).

Table (41): Comparison between both groups regarding soft tissue measurements:

Difference Soft tissue Measurements	Group I		Group II		P value
	MD	SD	MD	SD	
Ls/E-line distance	0.10	0.70	-0.40	2.34	0.75
Li/E-line distance	-0.36	0.96	-0.63	2.13	0.71
NLA angle	1.17	3.37	0.61	3.98	0.35

SD: standard deviation *MD: mean difference*

P: probability level which is significant at $P \leq 0.05$

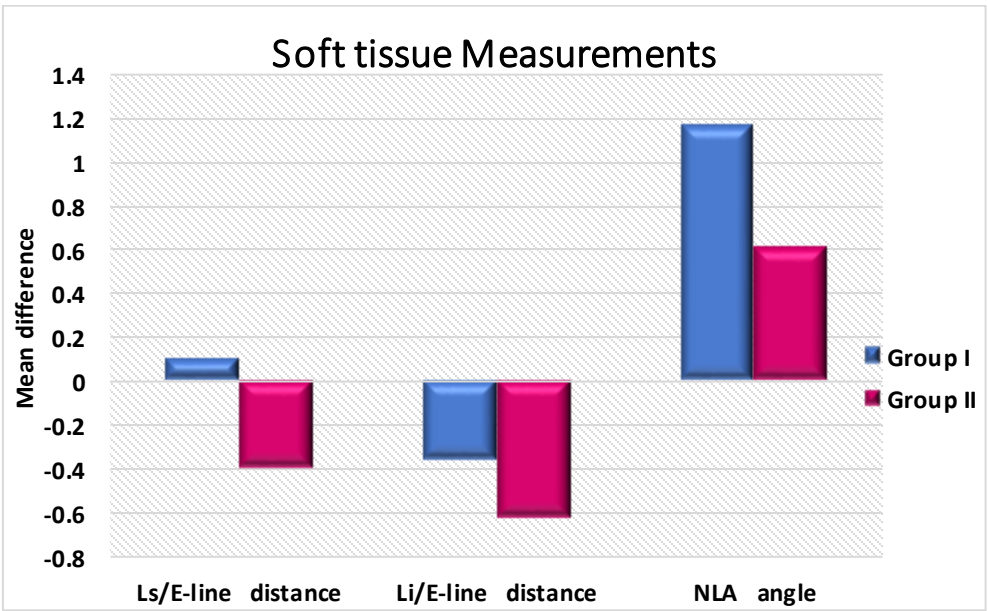

Figure (85): Bar chart showing comparison between both groups regarding soft tissue measurement