# CHAPTER 3

# RESULT

The 14 hemimandibles were devided into 2 groups that are Ti group and Re group . The specimens were mounted in the custom made cradle and each specimen was applied force from 0 N to failure point that were recorded the maximum load (N), the deflection of maximum load (mm), the stiffness(N/mm), the load at rupture (N), the deflection at rupture (mm) are shown in table 2.

**Table 2 The result record after the specimen were applied force in all groups.**

| Plate | Max.load (N) | Deflection at max. load (mm) | Stiffness (N/mm) | Load at rupture(N) | Deflection at rupture(mm) |
|---|---|---|---|---|---|
| **Ti gr.1sub1** | 289.00 | 17.45 | 13.60 | 52.25 | 25.03 |
| **Ti gr.1sub2** | 285.00 | 16.55 | 13.87 | 24.70 | 23.56 |
| **Ti gr.1sub3** | 280.00 | 16.29 | 12.56 | 141.25 | 20.46 |
| **Ti gr.2sub1** | 290.00 | 16.77 | 14.34 | 67.20 | 26.15 |
| **Ti gr.2sub2** | 281.00 | 17.20 | 14.52 | 110.50 | 24.39 |
| **Ti gr.2sub3** | 286.00 | 15.35 | 13.99 | 112.50 | 22.57 |
| **Ti gr.3 control** | 342.00 | 19.39 | 14.53 | 335.50 | 25.30 |
| **Re gr.1 sub1** | 230.00 | 11.13 | 13.35 | 136.50 | 12.85 |
| **Re gr.1 sub2** | 238.00 | 11.58 | 12.90 | 100.15 | 14.92 |
| **Re gr.1 sub3** | 240.00 | 17.00 | 13.90 | 82.25 | 19.25 |
| **Re gr.2 sub1** | 245.00 | 16.16 | 14.83 | 95.25 | 19.00 |
| **Re gr.2 sub2** | 239.00 | 14.59 | 13.03 | 81.50 | 15.63 |
| **Re gr.2 sub3** | 242.00 | 12.61 | 13.86 | 81.25 | 16.76 |
| **Re.gr.3 control** | 247.00 | 18.06 | 11.46 | 140.55 | 21.03 |

**The titanium group**

The titanium plates and screws were fixed in subject 1-7(Ti 1-Ti 7) after was applied the vertical loading that found the plates were bent and the proximal segment was moved forward and downward that were shown in Fig. 26. The screws remained on placed but the screw

engage of some screws were changed from level 0 to level II. that was shown in table 5 and table 6. The titanium group 1(Ti1-Ti3) compared with the titanium group 2(Ti4-Ti6) found that the movement of proximal segment of titanium group 2 is more than titanium group1. The titanium group 3(Ti 7) was found the movement of proximal segment is less than the titanium group 1,2 (Ti1-Ti3, Ti4-Ti6).

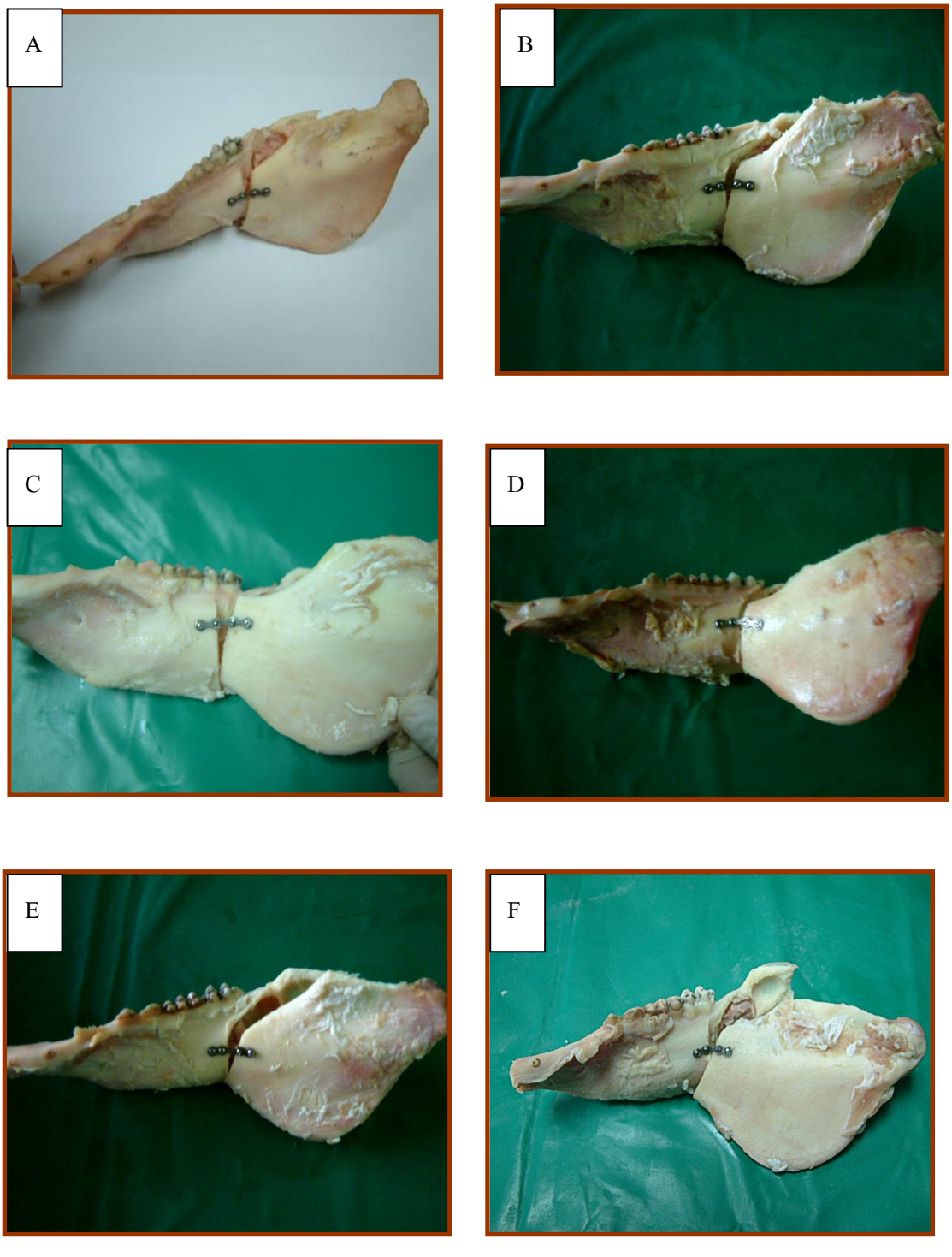



**Fig. 19** The titanium plates and screws after applied vertical loading.

A. group 1 (titanium )subject 1, B. group 1 (titanium )subject 2

C. group 1 (titanium )subject 3, D. group 1 (titanium )subject 4

E. group 1 (titanium )subject 5, F. group 1 (titanium )subject 6

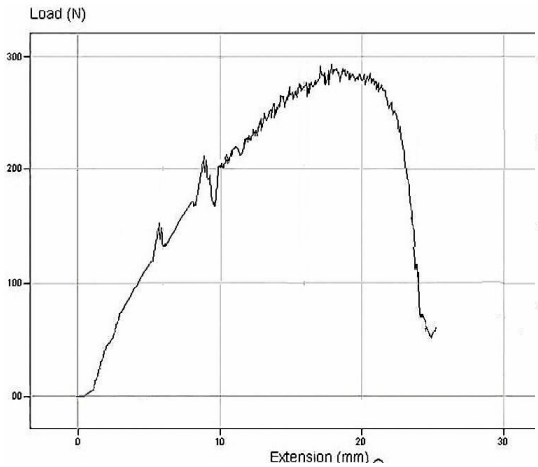
G. group 1(titanium ) subject 7 ( control)

The titanium group :graph 1,2,3 show the titanium group 5 mm set back subject 1-3(Ti1-Ti 3) shown the mechanical data are maximum load 280, 285, 289 N, the stiffness 12.56, 13.60, 13.87 N/mm, the deflection of maximum load 16.29, 16.55, 17.45 mm, the load at rupture 24.70, 52.25, 141.25 N and the deflection of load at rupture 20.46, 23.56, 25.03 mm .

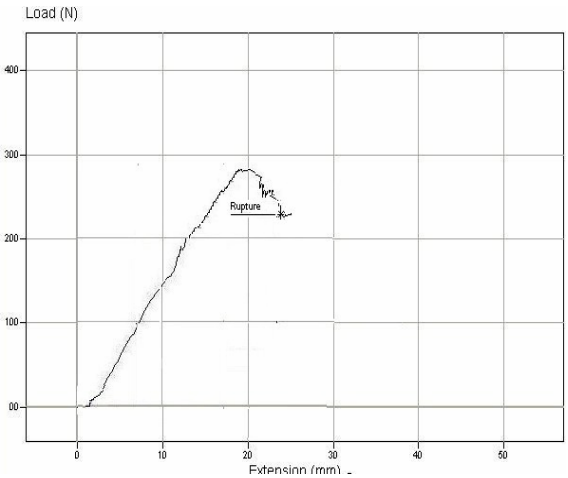
The titanium group : graph 4, 5,6 show the titanium group 10 mm set back subject 4-6 (Ti4-Ti6) shown the mechanical data are maximum load 281, 286, 290N, the stiffness 13.99,14.34,14.52 N/mm, the deflection of maximum load 15.35, 16.77, 17.20 mm, the load at rupture 67.20, 110.50 ,112.50 N and the deflection of load at rupture 22.57, 24.39, 26.15 mm.

The graph 7 shows the titanium group 0 mm as control subject 1 (Ti 7)that show the graph of the titanium group and the graph of the resorbable group are similar.

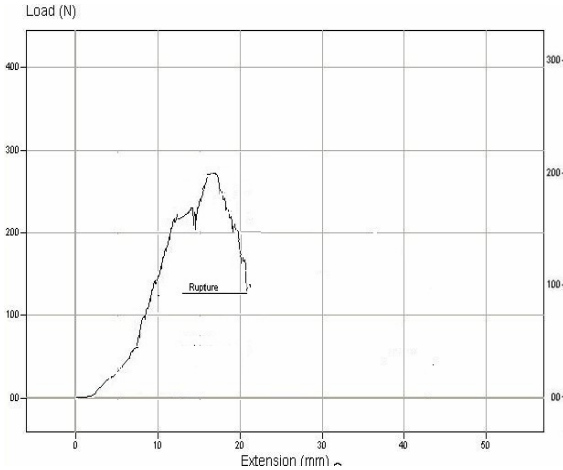
A


Load (N)
300
200
100
00
0
10
20
30
Extension (mm)

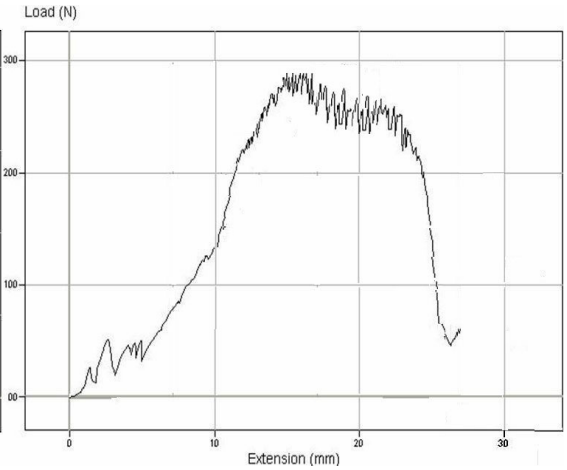
B


Load (N)
400
300
200
100
00
Rupture
0
10
20
30
40
50

C


Load (N)
400
300
200
100
00
Rupture
0
10
20
30
40
50
Extension (mm)

D


Load (N)
300
200
100
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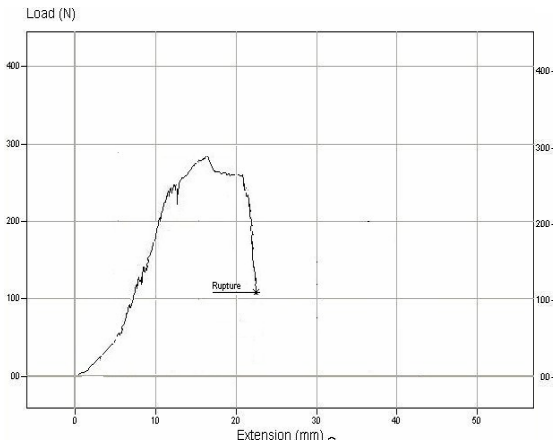
0
10
20
30
Extension (mm)

E


Load (N)
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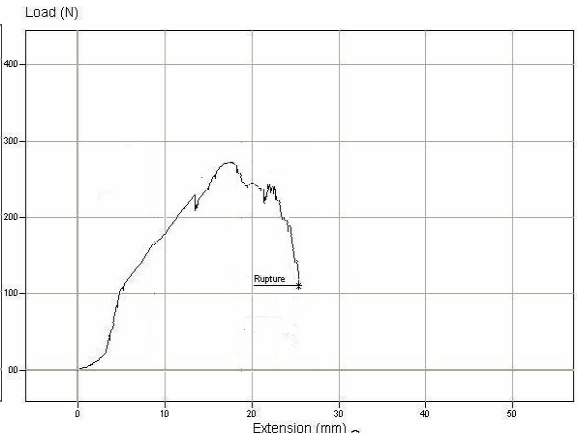
200
100
00
Rupture
0
10
20
30
40
50
Extension (mm)

F


Load (N)
400
300
200
100
00
Rupture
0
10
20
30
40
50
Extension (mm)

G

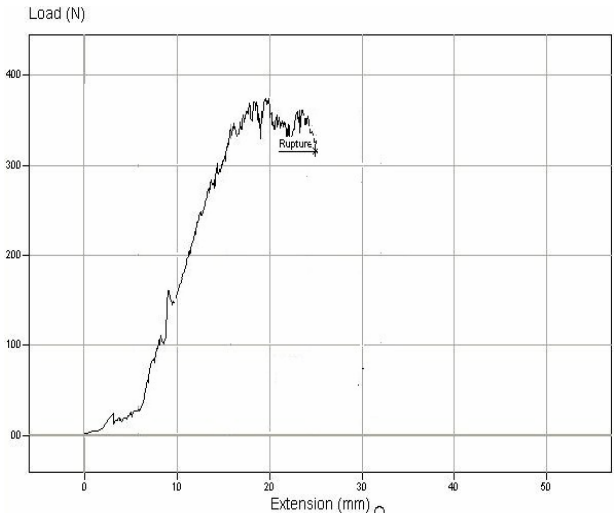



**Fig. 20** The graphs demonstrated the load/displacement curve in the titanium group.

A. group 1 (titanium ) subject 1, B. group 1 (titanium ) subject 2

C. group 1 (titanium ) subject 3, D. group 1(titanium ) subject 4

E. group 1 (titanium ) subject 5, F. group 1 (titanium ) subject 6

G. group 1 (titanium ) subject 7 (control)

## The resorbable group

The resorbable plates and screws were fixed in subject 1-7(Re1-Re7) were shown in Fig.28 that found the plates remained in same shape, no fracture but some plates were moved from the distal segment of the specimen in Re 3,Re 5 and were moved from the proximal segment in Re 4. The screws of Re3,Re4,Re5 were broken that made screw engage is 999. The proximal segments were moved forward and downward.

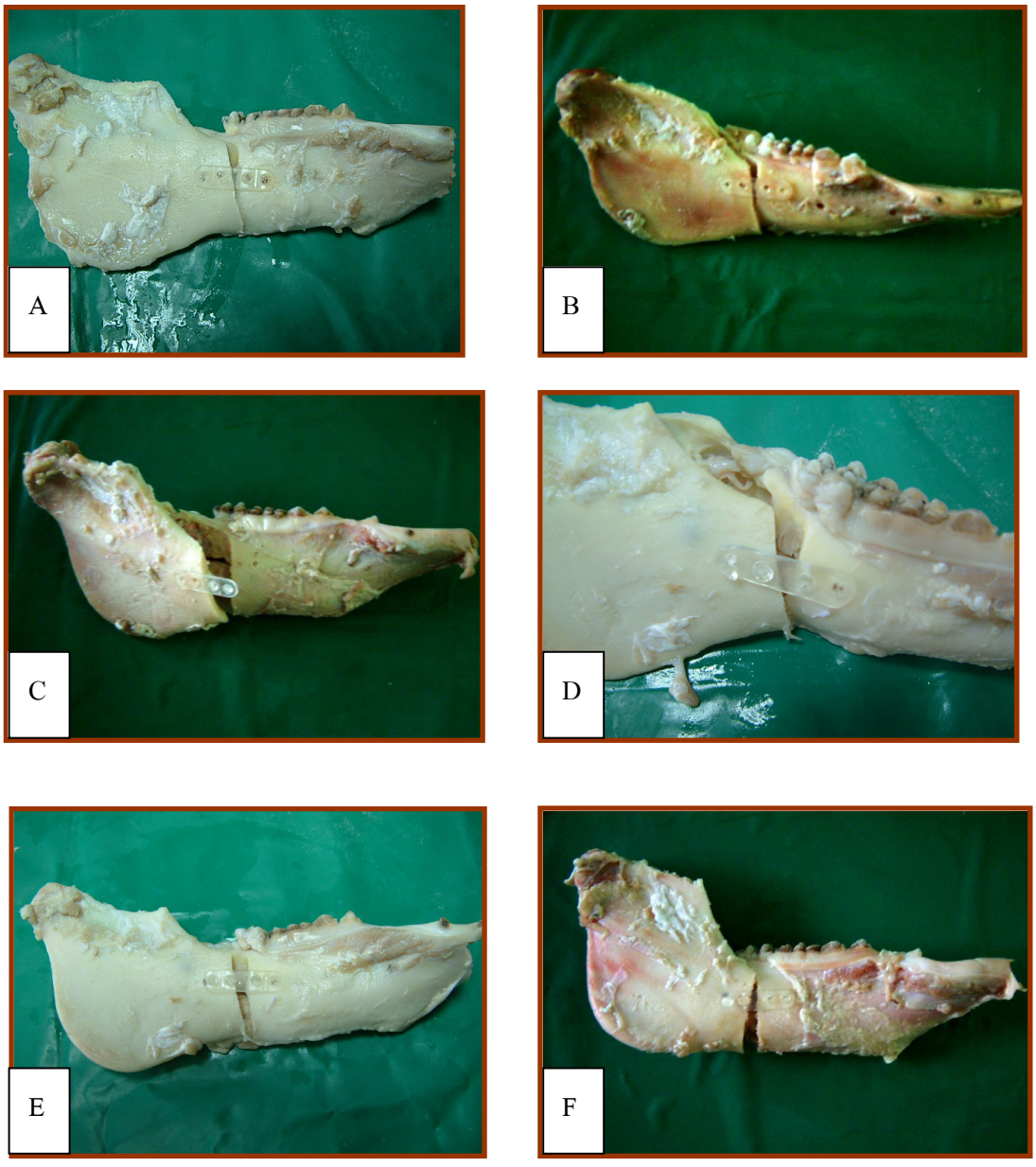
The resorbable group 1(Re 1-Re3) compared with the resorbable group2 (Re 4-Re6) found that the movement of proximal segment of the resorbable group2 is more than resorbable group1.The resorbable group 3(Re7) was found the movement of the proximal segment is less than the titanium group 1,2 (Re1-Re3, Re 4-Re 6).

The resorbable group : graph 1,2,3 show the resorbable group 5 mm set back subject 1-3 (Re1-Re3) shown the mechanical data are maximum load 230, 238, 240 N, the

stiffness12.90,13.35,13.90 N/mm, the deflection of maximum load 11.13,11.58,17.00 mm, the load at rupture 82.25,10015,136.50 N and the deflection of load at rupture 12.85,14.92,19.25 mm .

The resorbable group :graph 4,5,6 show the resorbable group 10 mm set back subject 4-6 (Re 4-Re 6) shown the mechanical data are maximum load 239, 242, 245 N, the stiffness 13.03, 13.86, 14.83 N/mm, the deflection of maximum load 12.61,14.59,16.16 mm, the load at rupture 81.25-95.25 N and the deflection of load at rupture 15.63, 16.76, 19.00 mm.

The graph 7 shows the resorbable group 0 mm as control subject 1 (Re 7) that show the graph of the titanium group and the graph of the resorbable group are similar.



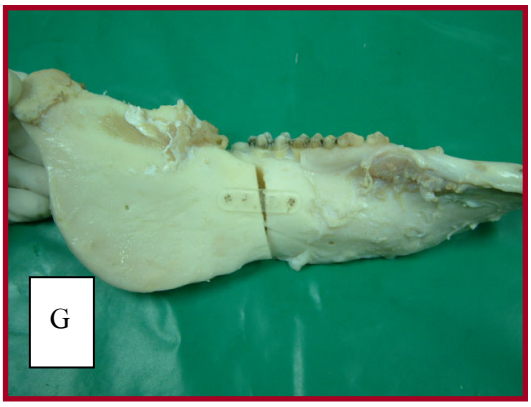


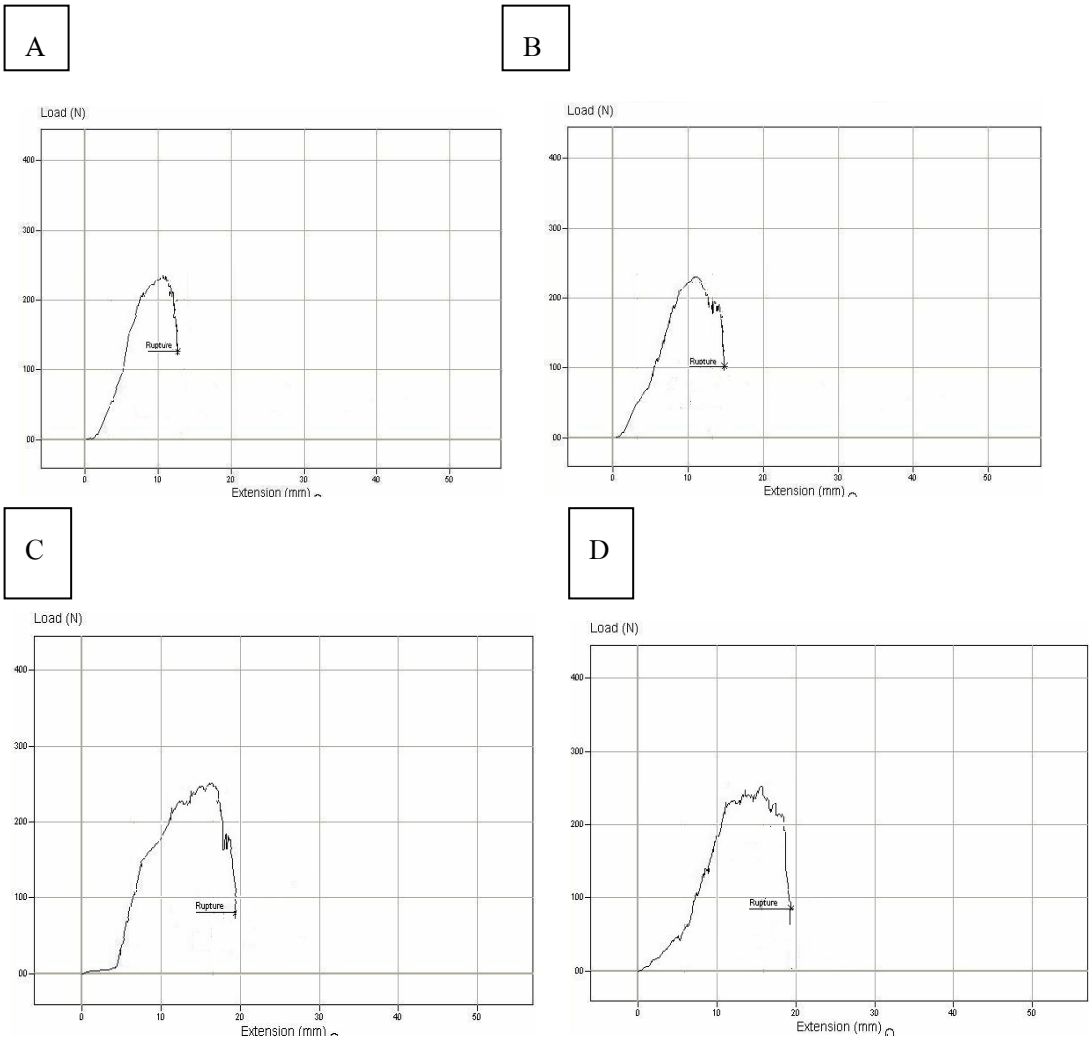

**Fig. 21** The resorbable plate and screws after applied vertical loading.

A. group 2 (resorbable) subject 1, B. group 2 (resorbable) subject 2

C. group 2 (resorbable) subject 3, D. group 2 (resorbable) subject 4

E. group 2 (resorbable) subject 5, F. group 2 (resorbable) subject 6

G. group 2 (resorbable) subject 7 (control)



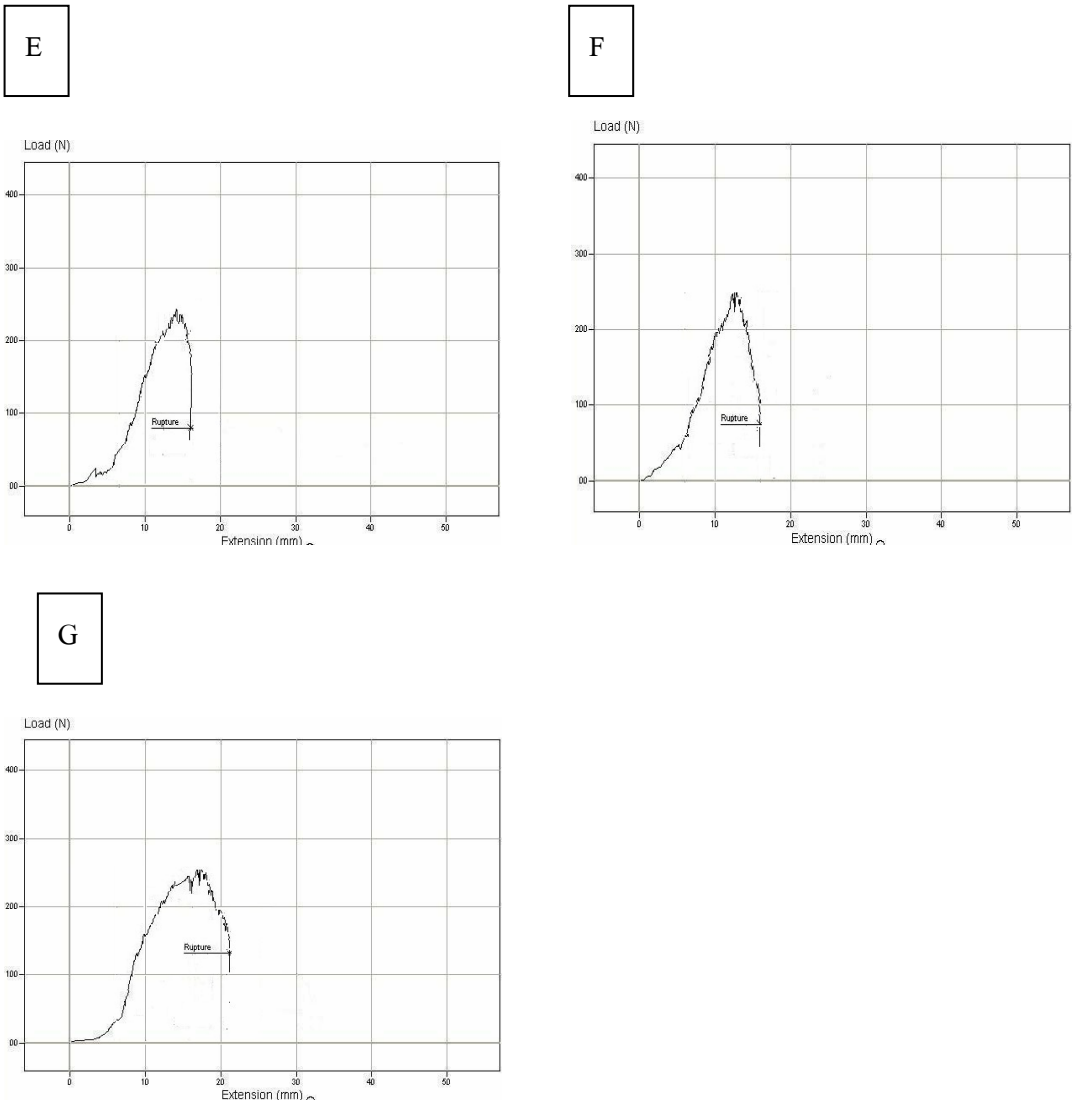



**Fig. 22** The graphs demonstrated the load/displacement curve in the resorbable group.

A. group 2 (resorbable) subject 1, B. group 2 (resorbable) subject 2

C. group 2 (resorbable) subject 3, D. group 2 (resorbable) subject 4

E. group 2 (resorbable) subject 5, F. group 2 (resorbable) subject 6

G. group 2 (resorbable) subject 7 (control)

The comparison of the 2 treatments groups in table 3 shows the mean ± SD of stiffness (13.81±0.7 N/mm), maximum load (285.17±4.07 N), deflection at the maximum load (20.69 ±0.0996 mm), load at rupture( 63.10± 2.45 N) and deflection at rupture(27.70±1.12 mm) were recorded in the titanium group and the mean ± SD of stiffness (13.65±0.71 N/mm), maximum load (239.00±5.06 N), deflection at the maximum load (19.10±1.21 mm), load at

rupture(46.75± 6.73 N) and deflection at rupture (22.82± 3.10 mm) were recorded in the resorbable plate and screws. The statistic analysis of all biomechanical data are no significant at $p< 0.05$.

**Table 3 Comparison of the two treatment groups**

| | Titanium group (n=6) | Resorbable group (n=6) | P-value (Sig. p < 0.05) |
|---|---|---|---|
| **Stiffness (N/mm)** | 13.81±0.70* | 13.65 ± 0.71* | 0.537 |
| **Maximum load (N)** | 285.17 ± 4.07* | 239.00± 5.06* | 0.085 |
| **Deflection at maximum load (mm)** | 16.60± 0.74* | 13.85± 2.45* | 0.327 |
| **Load at rupture(N)** | 121.78 ± 69.41* | 96.15 ± 21.35* | 0.057 |
| **Deflection at rupture(mm)** | 23.69± 2.00* | 16.40 ± 2.47* | 0.098 |

*Mean ± SD.

The statistics data compared within group and between group in the table4 show all of the mechanical data of (Ti.gr.1-Ti.gr.2), (Ti.gr.2-Ti. gr.3), (Ti gr.2-Ti gr.3), (Re gr.1 – Re .gr.2 ), (Re gr. 2-Re gr.3), (Re gr.2-Re gr.3) and (Ti gr.1-Re.gr. 1), (Ti gr. 2-Re gr. 2) that no significant at $p<0.05$.

**Table 4 The statistics data compared within group and between group.**

| Group | Mann-Whitney U test (sig*. at p<0.05) | | | | |
|---|---|---|---|---|---|
| | **Maximum load** | **Deflection at maximum load** | **Stiffness** | **Load at rupture** | **Deflection at rupture** |
| **Ti gr.1-Re.gr.1** | 0.050 | 0.75 | 0.827 | 0.513 | 0.050 |
| **Ti.gr2-Re gr.2** | 0.050 | 0.127 | 0.513 | 0.513 | 0.050 |
| **Ti gr.1-Ti.gr.2** | 0.513 | 0.827 | 0.050 | 0.513 | 0.513 |
| **Ti gr. 1-Ti gr.3** | 0.134 | 0.134 | 0.134 | 0.134 | 0.317 |
| **Ti gr.2 -Ti gr.3** | 0.180 | 0.665 | 0.180 | 0.180 | 0.180 |
| **Re.gr.1-Re.gr.2** | 0.127 | 0.827 | 0.513 | 0.827 | 0.513 |
| **Re gr.1- Re gr.3** | 0.180 | 0.180 | 0.180 | 0.180 | 0.180 |
| **Re gr.2- Re gr.3** | 0.665 | 0.180 | 0.180 | 0.180 | 0.180 |

From biomechanical data, they can make the graph for observation the relation between the type of plate and the maximum load of all groups (Fig .23), (Fig.27) and the type of plate and the stiffness of all groups (Fig.26), (Fig.30).

Graph of the titanium groups and the stiffness was plotted in Fig. 29 and the resorbable groups and the stiffness was plotted in Fig. 28. Graph of the maximum load and the deflection at maximum load was plotted in Fig. 24 and the load at rupture and the deflection at rupture was plotted in Fig.25.

Graphs of the load-displacement of the specimens in the titanium group was shown in Fig.20. In the titanium group , graph 1,2,3 show the titanium group 5 mm set back subject 1-3 (Ti 1-Ti 3) and graph 4,5,6 show the titanium group 10 mm set back subject 1-3(Ti 4-Ti 6) and graph 7 shows the titanium group 0 mm as control subject 1 (Ti7) that shown the mechanical data are maximum load 280-342 N, the stiffness 12.56-14.53 N/mm., the deflection of maximum load 15.35-19.39 mm, the load at rupture 24.70-335.50 N and the deflection of load at rupture 20.46-26.15 mm.

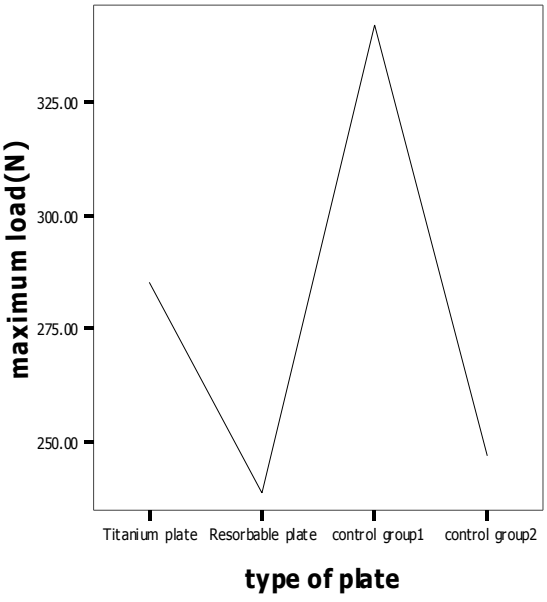



**Fig. 23** The graph showed the relation between the type of plate and the maximum load.

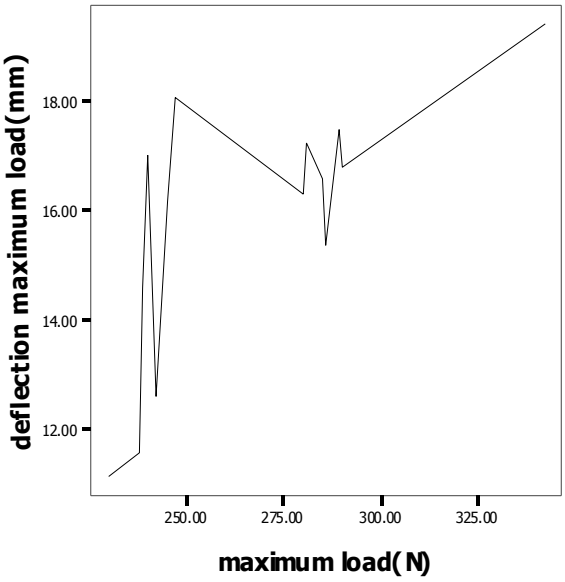



**Fig. 24** The graph showed the relation between the maximum load and the deflection of maximum load .

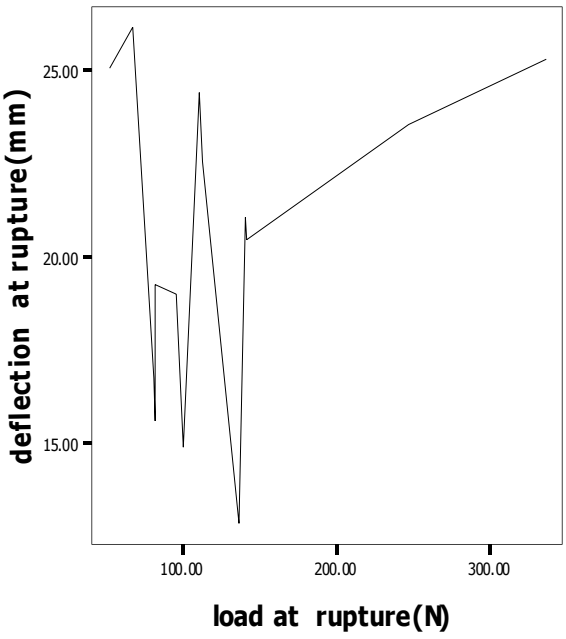



**Fig. 25** The graph showed the relation between the load at rupture and the deflection at rupture.

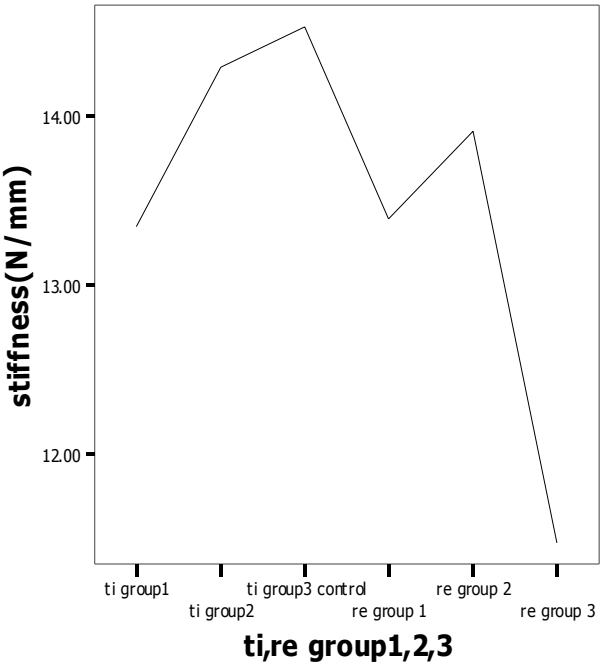



**Fig. 26** The graph showed the relation between the Ti ,Re group 1,2,3 and the stiffness.

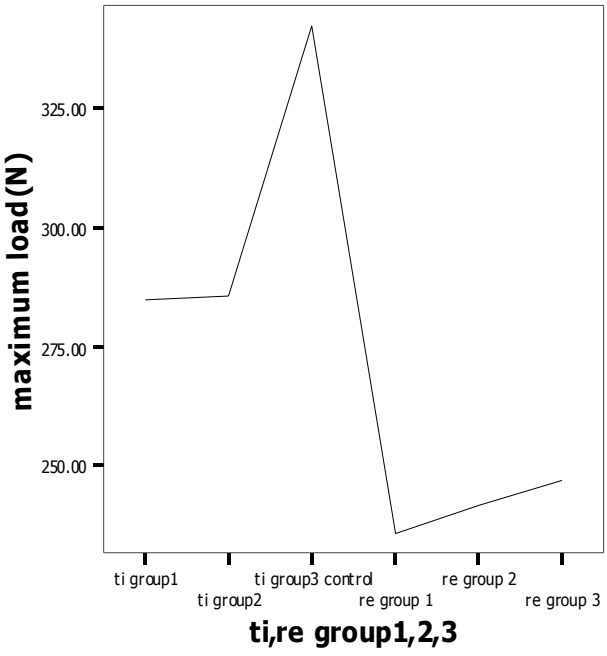



**Fig. 27** The graph showed the relation between the Ti ,Re group 1,2,3 and the maximum load.

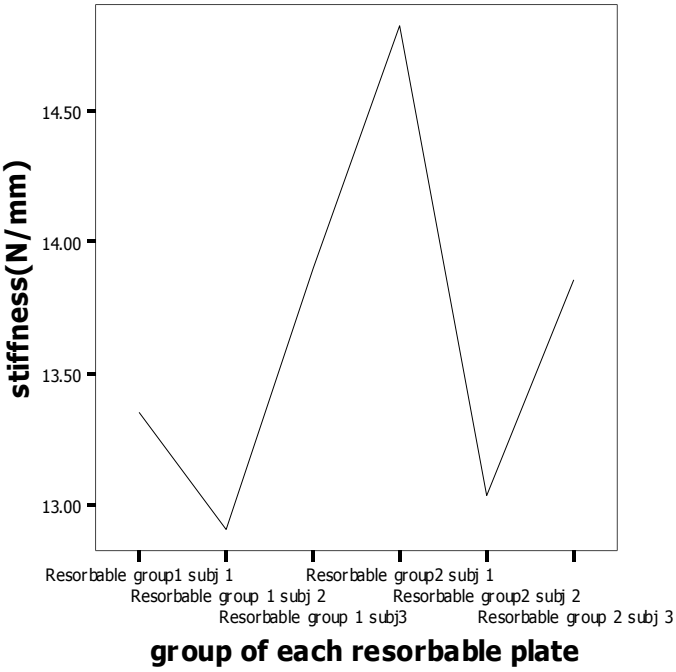



**Fig. 28** The graph showed the relation between the Re group 1,2,3 and the stiffness.

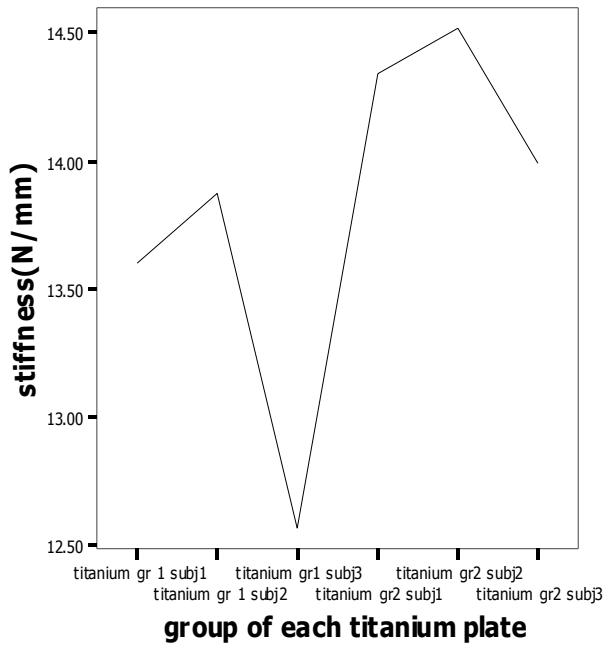



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**Fig. 29** The graph showed the relation between the Ti group 1,2,3 and the stiffness.

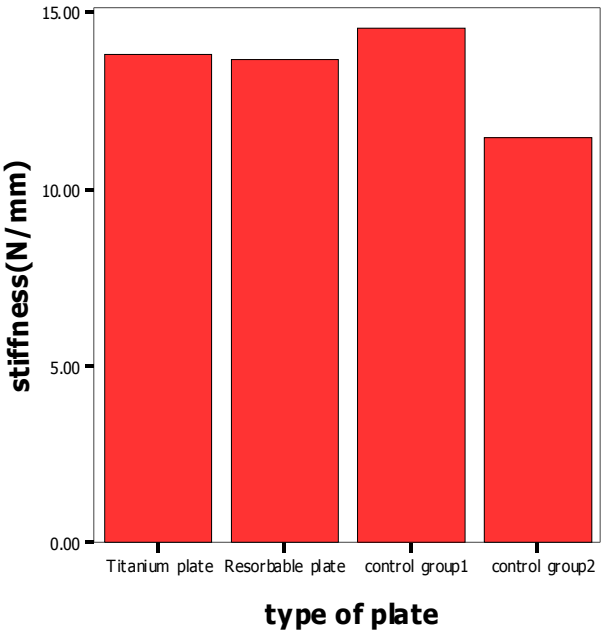


**Fig. 30** The bar graph demonstrated the relationship between the type of plate and the stiffness.

## The screw engagement

The value of the screw engagements before the mechanical testing in table 5 are in level 0-level I. The value of the screw engagements after the mechanical testing in table 6 are in level 0–level II and the mean± SD and SE. Mean of the mean of screw 1,2,3,4 before and after testing in table 7 found that the screw engage of all screw is decreased after testing.

**Table 5 The data showed the screw engagement values before the biomechanical testing of all specimens.**

| Type of plate | Perio –test before loading | | | | |
|---|---|---|---|---|---|
| | mean screw 1 | mean screw 2 | mean screw 3 | mean screw 4 | mean |
| **Ti 1** | -2.00 | -7.00 | -3.00 | -1.33 | -3.33 |
| **Ti 2** | -5.67 | -4.00 | -8.00 | -8.00 | -6.42 |
| **Ti 3** | -4.67 | -5.67 | -5.67 | -4.00 | -5.00 |
| **Ti 4** | -2.67 | -4.67 | -3.67 | -2.67 | -3.42 |
| **Ti 5** | -2.00 | -1.33 | -3.67 | -1.67 | -2.17 |
| **Ti 6** | -6.00 | -1.67 | -3.67 | -4.00 | -3.83 |
| **Ti 7** | -2.67 | -3.67 | -4.67 | -3.67 | -3.67 |
| **Re 1** | -4.33 | -3.33 | -5.00 | -3.33 | -4.00 |
| **Re 2** | -2.67 | 1.33 | -1.67 | -3.33 | -1.58 |
| **Re 3** | -1.00 | -1.33 | -5.33 | 0.67 | -1.75 |
| **Re 4** | -4.67 | -2.67 | -5.33 | -4.33 | -4.25 |
| **Re 5** | -1.67 | -1.00 | -3.33 | -1.33 | -1.83 |
| **Re 6** | -1.00 | -2.00 | -5.33 | -3.33 | -2.92 |
| **Re 7** | -1.67 | -5.00 | -5.33 | -0.33 | -3.08 |

**Table 6 The data showed the screw engagement valuaes after the biomechanical testing of all specimens.**

| Type of plate | Periotest after loading | | | | |
|---|---|---|---|---|---|
| | mean screw 1 | mean screw 2 | mean screw 3 | mean screw4 | Mean |
| **Ti 1** | 29.33 | 12.00 | 28.00 | 2 | 17.83 |
| **Ti 2** | 6.00 | 11.67 | 0.67 | 13.33 | 7.92 |
| **Ti 3** | 22.67 | 11.33 | 22.67 | 16.67 | 18.33 |
| **Ti 4** | -2.67 | -4.67 | -3.67 | -2.67 | -3.47 |
| **Ti 5** | -2.00 | -1.33 | -3.67 | -1.67 | -2.17 |
| **Ti 6** | -6.00 | -1.67 | -3.67 | -4.00 | -3.83 |
| **Ti 7** | -2.67 | -3.67 | -4.67 | -3.67 | -3.67 |
| **Re 1** | -4.33 | -3.33 | -5.00 | -3.33 | - 4.00 |
| **Re 2** | -2.67 | 1.33 | 999 | 21.67 | 6.78 |
| **Re 3** | 999 | 999 | 32.67 | -1.00 | 10.11 |
| **Re 4** | -4.67 | -2.67 | 999 | 15.00 | 7.50 |
| **Re 5** | 22.33 | 999 | 19.00 | 17.67 | 18.33 |
| **Re 6** | -1.00 | -2.00 | 28.67 | 19.33 | 11.25 |
| **Re 7** | -1.67 | -5.00 | -5.33 | -1.17 | -3.29 |

*999 : broken plate and /or screw or loss of intact from cortex of specimen.

**Table 7 The statistics analysis of the screw engagement valuaes before –after testing.**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | mean of screw 1 of each group before testing | -3.0493 | 14 | 1.69402 | .45275 |
| | mean of screw1 of each group after testing | 75.1179 | 14 | 266.17199 | 71.13746 |
| Pair 2 | mean of screw2 of each group before testing | -3.0007 | 14 | 2.19580 | .58685 |
| | mean of screw 2 of each group after testing | 143.5707 | 14 | 362.46206 | 96.87206 |
| Pair 3 | mean of screw 3 of each group before testing | -4.5479 | 14 | 1.52708 | .40813 |
| | mean of screw 3 of each group after testing | 150.2621 | 14 | 359.86796 | 96.17876 |
| Pair 4 | mean of screw4 of each group before testing | -2.9036 | 14 | 2.10252 | .56192 |
| | mean of screw 4 of each group after testing | 6.2971 | 14 | 10.14409 | 2.71112 |
| Pair 5 | mean of all screw of each group before testing | -3.3750 | 14 | 1.34057 | .35828 |
| | mean of all screw of each group after testing | 5.5443 | 14 | 8.87941 | 2.37312 |

The stiffness of the titanium group and the resorbable group were shown in Fig. 31 found that the stiffness of the titanium group are similar to the stiffness of the resorbable group. The maximum load of the titanium group and the resorbable group were shown in Fig. 32 found that the maximum load of the titanium group were higher than the maximum load of the resorbable group but no significant difference were noted statistically ($p<0.05$). The deflection at maximum load in titanium group and resorbable group were shown in Fig. 33 found that the deflection at maximum load in titanium group were higher than the maximum load of the resorbable group but no significant difference were noted statistically ($p<0.05$) .

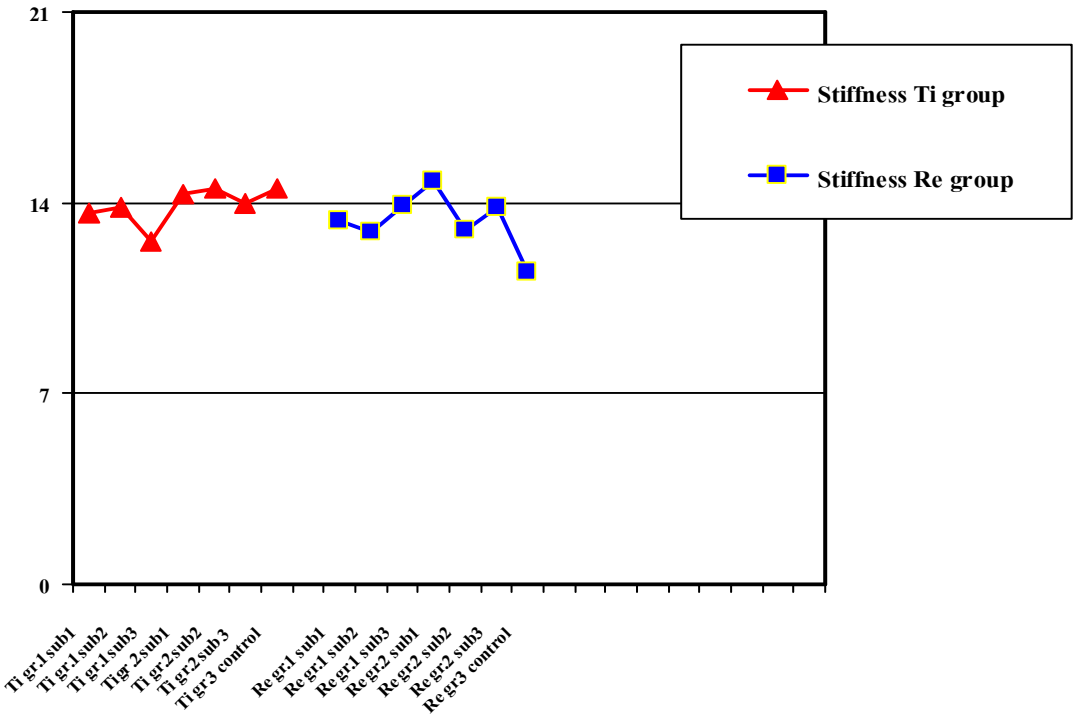


**Fig. 31** Graph show the stiffness in Ti. group and Re. group.

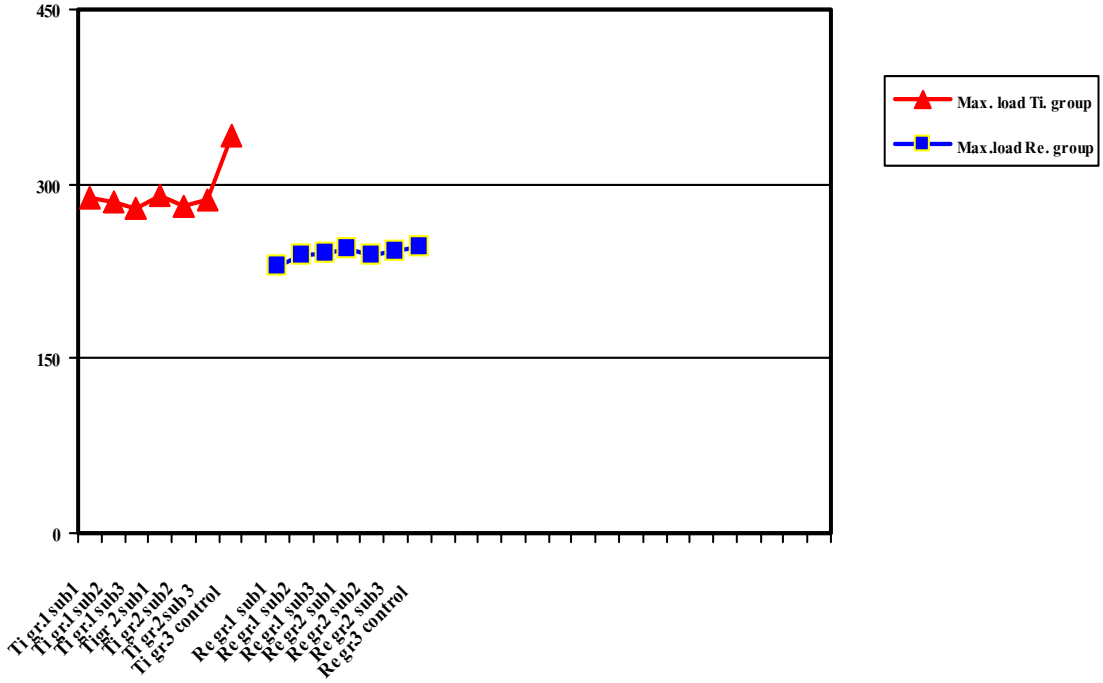


**Fig. 32** Graph show the maximum load in Ti. group and Re. group.

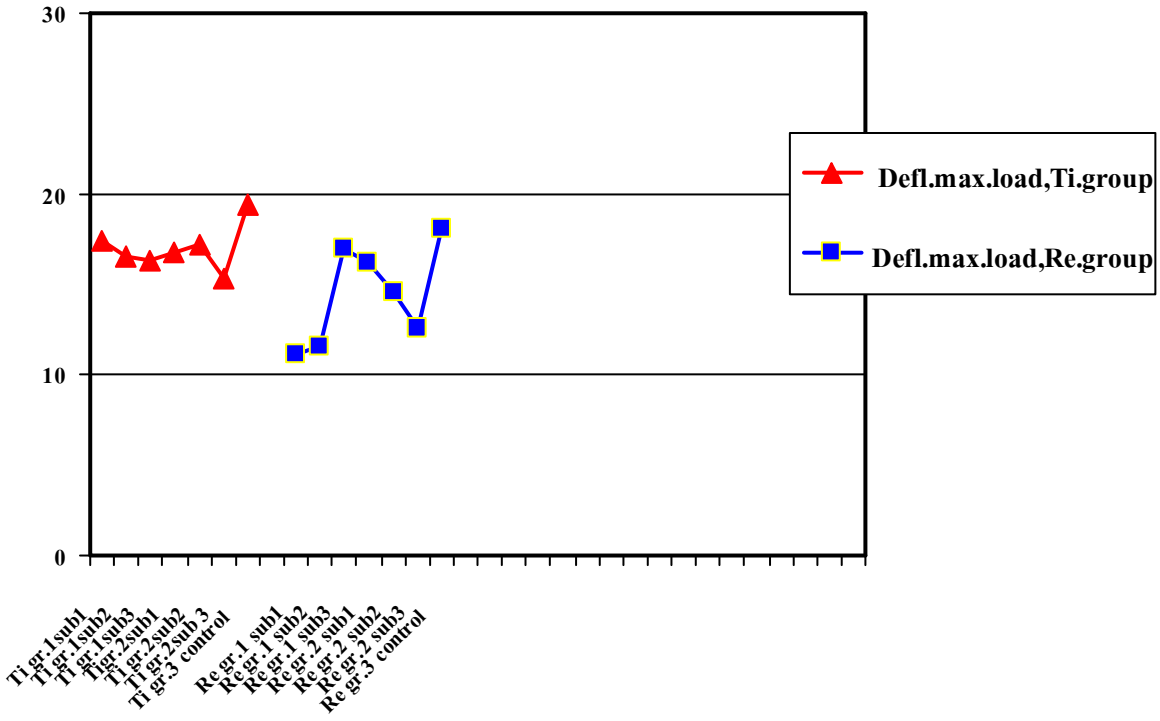


**Fig. 33** Graph show the deflection at maximum load in Ti. group and Re. group.