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Evaluation of Facial changes in patients with Class II Division 1 malocclusion with convex facial profile after treatment with functional appliance (Twin-block) followed by fixed orthodontic mechanotherapy – A Cephalometric Study

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Abstract

Introduction: Treatment of class 2 division 1 malocclusion at early stage requires 2 phase therapy phase 1 functional orthopedic appliances followed by phase 2 fixed orthodontic mechanotherapy which brings not only skeletal and dental hard tissue changes but also facial soft tissue changes which improves patients overall facial profile and appearances.

Materials & Methods: A retrospective study was conducted using cephalograms of 20 patients irrespective of gender who had been treated with functional orthopedic appliance (Twin Block) followed by fixed orthodontic appliances meeting inclusion and exclusion criteria.

Results: Facial changes with Twin block appliance followed by fixed mechanotherapy is evaluated using lateral cephalogram at different intervals. With Twin block there is significant increase in Z angle and decrease in H angle which suggest that forward positioning of soft tissue pogonion and so that there is decrease in facial convexity and improvement in facial profile is seen. Correction in class 2 skeletal pattern is due to increase in mandibular length and forward positioning of mandible. Along with these skeletal changes there are improvement in dental relationship and soft tissue profile.

Conclusion: Treatment with twin block appliance followed by fixed mechanotherapy improves patient's oral function as well as facial appearance.

Keywords: Cephalometry, Twin-Block appliance

Introduction

Treatment of class 2 division 1 malocclusions with mandibular deficiency depends on several factors, such as patient age, esthetic compromise, and severity of malocclusion. It may be performed in 2 phases (orthopedic and orthodontic with a fixed appliance) or in 1 phase (fixed appliance alone). There has been considerable debate on the merits of early orthodontic treatment for Class II Division 1 malocclusions.

The significance of removable appliances have been reported in the literature for the correction of the Skeletal Class II division 1 malocclusion with mandibular deficiency with the main mode of action of altering/stimulating the mandibular growth and/or the subsequent forward positioning the mandible. The selection of the appliance varies according to the patient's need, the clinician's preference, type of the anomaly and the growth pattern.

One of the major objectives of orthodontic treatment is to improve facial attractiveness. To orthodontists this invariably means that the nose, lips, and chin form an attractive outline when the face or a standardized image of the face is viewed from one side. Various studies has been done till now on to study the effects of various removable functional appliances on mandibular growth and effects on improving facial esthetics among them very few studies are present which include both removable functional therapy followed by fixed orthodontic treatment for class 2 division 1 malocclusion and its effect on improving facial profile

Materials and Methods

A retrospective study was conducted using pretreatment and post treatment cephalograms of 20 patients irrespective of gender who had been treated with functional orthopedic appliance (Twin Block) followed by fixed orthodontic appliances.

Inclusion criteria

1. Class II Division 1 malocclusion (Class II, more than half cusp in molars bilaterally)
2. ANB angle greater than 3^0 and with SNB angle less than 78^0
3. Overjet more than 5 mm
4. Late mixed dentition or early permanent dentition at the beginning of orthodontic treatment
5. Age at the beginning of the treatment was 10 to 14 years
6. Full initial and final diagnostic records (medical, dental, and orthodontic histories, panoramic and lateral cephalometric radiographs, dental casts, intraoral and extra oral photographs of good quality and without obvious positional or other errors)
7. Subjects who received complete treatment with functional and fixed orthodontic appliances
8. Non-extraction treatment (excluding third molars)

Exclusion criteria

Any other malocclusion than class 2 division before treatment

1. Facial asymmetry present between right and left side of the face.
2. Discontinuation of the treatment for any reason within 6 months of the start of the treatment.
3. Any missing teeth
4. Any craniofacial anomaly
5. History of bone and blood disorders
6. History of dental or facial trauma, jaw injury
7. Extraction cases

All the patients were treated with removable functional appliance (Twin block) followed by fixed orthodontic therapy (0.022 MBT PEA System).

Cephalometric radiograph of patients taken at three different intervals were analyzed: T0, T1 and T2

T0 – Pre-treatment

T1 – after completion of treatment with Twin block functional orthopedic appliance

T2 – after completion of fixed orthodontic treatment

All cephalometric radiograph were analyze using "**Dolphin imaging software™ (version 11.5)**".

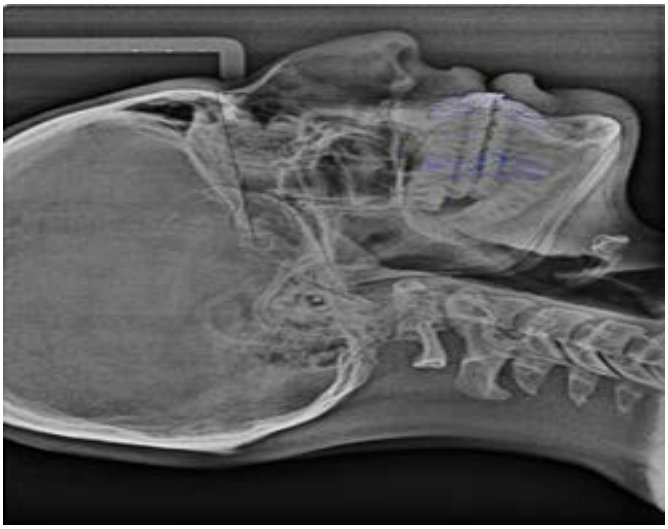

Figure: T0

Figure: T1

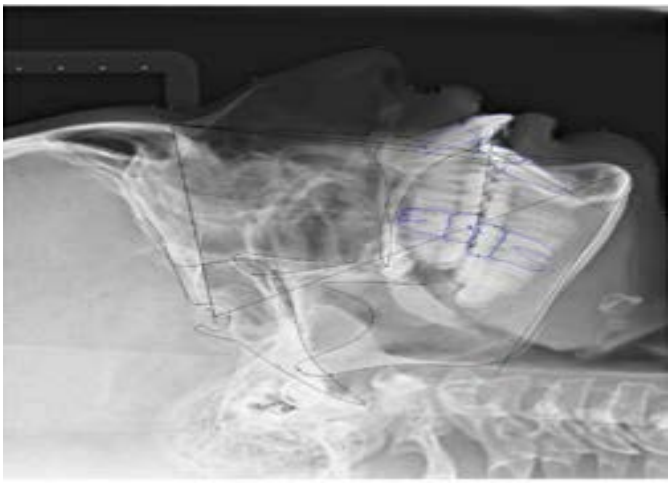

Figure: T 2

Figure: Traced lateral cephalograms at TO pretreatment, T1 after completion of my of functional appliance therapy and T2- after completion of fixed orthodontic mechanotherapy in Dolphin Imaging Software™ (Version 11.5).

Results

Table shows mean difference and standard deviation for all selected parameters at T0 to T1 (pre-treatment and after completion of myofunctional appliance therapy) , T1 to T2 (after completion of myofunctional appliance therapy and after fixed orthodontic mechanotherqapy) and T0 to T2 (pre-treatment and after completion of myofunctional therapy followed by fixed mechanotherapy)

For statistical significance difference paired T-test for means was performed and significance levels for mean difference were represented by p value.

From **TO to T1** there were significant difference were found in SOFT TISSUE FACIAL ANGLE (FH -N'Pog') , H ANGLE (N'Pog'- Pog'Ls), Z angle, SNB, SND, ANB, WITS, SADDLE ANGLE, GONIAL ANGLE, L.A.F.H., Ant. Facial Height, JARABACK'S RATIO, FACIAL CONVEXITY, CO-B, DIFFERNCE BETWEEN CO-A AND CO-B, GO-GN and IMPA.

From **T1 to T2** there were significance difference were found in U1-NA (°), U1-SN.

From **T0 to T2** there were significant difference were found in SOFT TISSUE FACIAL ANGLE (FH - N'POG'), H ANGLE(N'POG'- POG'LS), SN- H LINE, LL- S LINE, Z ANGLE, SNB, SND, ANB, WITS, SADDLE ANGLE, GONIAL ANGLE, L.A.F.H., ANT. FACIAL HIGHT, JARABACK'S RATIO, FACIAL CONVEXITY, CO-B, DIFFERENCE CO-A & CO-B, GO-GN, U1-NA(°), U1-NA(MM), L1-NB(°), U1-SN.

Discussion

Soft tissue

Upper and lower lip position: Quintao et al[5] found a significant change in upper lip position due to maxillary incisor retroclination after functional appliance treatment. In contrast, Morris et al, in their study, demonstrated no significant change in the sagittal position of upper lip despite large reductions in overjet. In study by Khoja A et al.[1] found that upper lip became significantly less projected in the treatment group when compared to the controls. Baysal and Uysal[2] found greater advancement of the lower lip, lower lip sulcus and soft tissue pogonion in the Twin Block group. In contrast, Quintão et al[5] in their study, did not find any significant changes in any of the lower lip variables. Lower Lip changes were observed only in the CS-2 group. However, the E-line, as a reference plane to quantify actual changes in lips, is not very reliable because of the simultaneous growth of the soft tissue chin and pronasale that may give a false impression of the actual lip position. Comparing result of present study to these studies there is no significant changes observed in upper and lower lip.

Nasolabial angle

Quintão et al[5] in their study, did not find any statistically significant change in the nasolabial angle after treatment with the Twin Block appliance. In contrast, Varlik et al[6] found significant increase in nasolabial angle in the Twin Block group. In study by Khoja A et al[1] found that significant increase in the nasolabial angle, which may be the result of the change in upper lip position. On stratification of sample into different cervical stages, this increase was significant at the CS-4 stage when compared to controls. In present study there is decrease in nasolabial angle at T0-T1 but it was not significant.

Z-angle

Varlik et al[6] in their study, found a significant increase in Z-angle in patients treated with the Twin Block appliance due to forward movement of soft tissue chin. In study by Khoja A et al[1] found that increase was significant only at the CS-3 stage when compared to controls. In present study, there is significant increase in z angle, at T0-T1 there is increase of 3.22±1.77° ($p < 0.001$), while no change in T1-T2. While significant increase at T0-T2 is 3.32±1.18° ($p < 0.001$)

H-angle

Holdaway related H-angle decreases as the facial convexity decreases. Baysal and Uysal[2] in their study, found a significant reduction in this angle after Twin Block appliance treatment, which showed improvement in facial convexity. In study by Khoja A et al[1]. found that significant reduction in this angle at the CS-2 and CS-3 stages, with an overall improvement of facial profile. The possible explanation for this reduction in H-angle is the combination of upper lip retraction and forward movement of the soft tissue pogonion. In present study, there is significant decrease in H angle, at T0-T1 there is decrease of 1.42±1.45° ($p < 0.001$), while no change in T1-T2. While significant decrease at T0-T2 is 1.57±1.22° ($p < 0.001$).

Maxillary skeletal

O'Brien et al [12] found minimal restraining effect on maxillary growth with the Twin Block appliance, which constituted 13% of overall skeletal changes Illing et al[7] found that there was mean reduction in SNA angle with twin block appliance. Panchers et al found mean reduction of -0.4±1 degree, though minimal while, Chura et al found that reduction in SNA -0.7±1.7 degree. Due to the stretch of the muscles and surrounding soft tissues of the facial skeleton, the forwardly placed mandible tends to return to its original position. This creates a reciprocal restraining effect on the maxilla,

which is called headgear effect. Sachdev V et al in their study found that there was decrease in SNA angle by mean of 0.05±0.707° and there was increase in CO-A midface length. Study done by Jenna AK et al[8] and Gillmore et al. found no significant difference in SNA angle. Similarly, in study by Mills CM et al found no significant change in SNA and maxillary length (CO-A). The results obtained in the present study are in concordance with their study results, with no statistically significant reduction in SNA angle and no significant change in maxillary length (CO-A) .

Mandibular skeletal

Baysal and Uysal[2] found a significant increase in SNB angle after treatment with the Twin Block appliance. Illing et al[7] found an increase in mandibular unit length measured from point condylion to gnathion. Toth and McNamara[15] found an increase in mandibular unit length (Co-Gn) of 3.0 mm during a 16-month period when compared with controls. In studies done by Khoja A et al[41]significant increase in SNB angle by 1.56˚ and mandibular unit length of 3.27 mm over a 12-month period. They also found that there were greater mandibular skeletal changes in CS-3 and CS-4 groups, as compared to the CS-2 group. However, this increase was statistically insignificant. The greater therapeutic effectiveness of functional appliance occurs during the peak in the pubertal growth spurt of an individual, which coincides with the maximum growth rate of the mandible. Increase in SNB angle is suggested by Lund and Sandler[14], Trenouth[16] Sidlauskas, Clark[3], Mills and McCulloch[13]. Study by Lund and Sandler[14] found 2.4 mm extra mandibular growth between articulare and pogonion (total increase is 5.1 mm in Twin Block group; 2.7 mm in control group) during a 12-months period of Twin-Block treatment.

Mills and McCulloch[13] also found a greater mandibular growth (4.2 mm) with Twin Block therapy (total increase is 6.5 mm in Twin Block group; 2.3 mm in control group). Toth and McNamara[15] found 3.0 mm additional increase in condylion to gnathion length during a standardized 16-months period of Twin-Block therapy as compared to 1.9 mm increase in Frankal group (total increase is 5.7 mm, 3.6 mm, 2.7 mm in Twin Block group, Frankal group and control group, respectively). Sachdev V et al in their study found that significant increase in mandibular length following Twin-block treatment by 7.1 mm. This 7.1 mm increase in effective mandible length is combined effect of normal growth increment, effect of forward posturing of the mandible by appliance (effect of appliance) and downward and backward rotation of mandible (posterior mandibular morphogenetic rotation). Jena AK et al.[8] has found 1.65 mm and 1.05 mm extra mandibular growth following in the Twin Block and bionator group respectively compared with controls (total increase in mandible length was 5.02 mm in Twin Block group and 4.42 mm in bionator group, 3.37 mm in control group). In present study, at T0-T1 there is significant increase found in SNB, SND, CO-B and GO-GN. Mean increase in SNB is 2.68±0.93° ($p< 0.001$), SND is 2.44±0.98($p< 0.001$), CO-B is 1.67±1.5($p< 0.001$), GO-GN is 0.47±1.09($p=0.047$). There is no significant difference were found at T1-T2. But there are significant increase at T0-T2 for SNB is 2.88±1.16° ($p< 0.001$), SND is 2.82±1.27($p< 0.001$), CO-B is 1.47±1.63($p< 0.001$), GO-GN is 3.79±1.7($p=0.03$). these changes shows that there is forward positioning of mandible with twin-block appliance (increase in SNB, SND) and increase in effective mandibular length and mandibular body length. Pancherz[10] found an increase in the gonial angle of the patients of the Herbst group. He determined that by

changing the muscle functions or by sagittally directing condylar growth, there could be some resorption on the gonial region. This growth modification as suggested by the increase in gonial angle have previously been described as "posterior mandibular morphogenetic rotation" a biological mechanism leading to greater increments in total mandibular length and, thus, efficiently improving the skeletal sagittal relationships in Class II malocclusion. Sachdev V et al in their study found that gonial angle and lower gonial angle has increased; however changes in the lower gonial angle were statistically significant. Although, the increase in the lower gonial angle has to some extent being compensated by the decrease in upper gonial angle thereby reducing the net gonial angle. They hypothesize that this increase in lower gonial angle has an effect on the increase of the mandibular plane angle. In present study results are similar. There is statistically significant increase in gonial angle at T0-T1 3.64±1.46° (p=0.02) with twin block therapy, and at T0-T2 1.56±1.54° (p=0.04).

Maxillary-Mandibular Relationship

Changes in ANB would suggest that twin block in correcting sagittal discrepancy is most effective compare to other removable functional appliance. It was found that the reduction in ANB angle following Twin Block appliance therapy may occur by decrease in SNA and increase in SNB or both. Toth and McNamara[15] found reduction in ANB angle by 1.8˚ in patients treated with the Twin Block appliance. Likewise, Illing et al[7] found statistically significant reduction in ANB angle, as compared to controls. In studies done by Khoja A et al[1], mean reduction in ANB angle by 1.82˚ in the total sample. This reduction in ANB angle was primarily due to an increase in SNB angle in CS-2 and CS-3 groups; whereas, in CS-4, it occurred due to a combination of decrease in SNA angle and increase in SNB angle. Sachdev V et al in their study found that statistically significant reduction was observed in angle ANB by 2.9°. In present study there was significant decrease in ANB angle were noted. Mean decrease in ANB angle at T0- T1 is 3.06±1.06° (p<0.001) and at T0-T2 3.30±1.05° (p<0.001). There was no significant difference in ANB at T1-T2. To rule out any bias going to occur with Nasion as reference point, the effective maxilla-mandibular length difference were analyzed with WITS appraisal. There were significant decrease in CO-A and CO-B difference. Mean decrease in CO-A and CO-B difference at T0- T1 is 3.41±0.96 (p<0.001) and at T0-T2 3.47±0.96 (p<0.001). There was no significant difference in CO-A and CO-B difference at T1-T2. Similarly, there was significant decrease in WITS appraisal was noted. Mean decrease in WITS appraiasal at T0- T1 is 3.07±0.65 (p<0.001) and at T0-T2 3.13±0.65 (p<0.001). This findings are in agreement with results reported by Clark[3], Trenouth[16], Illing et al[7]., Lund and Sandler, Mills and McCulloch[13].

Changes in vertical relationship

Control of the vertical dimension is one of the proposed benefits of the Twin-Block appliance. Clark[3] has stressed selective removal of acrylic to allow an increase in the vertical dimension as an important component of Twin-Block therapy. There is significant increase in anterior facial height especially lower anterior facial height. Mean increase in anterior facial height at T0-T1 is 2.79±2.47 (p<0.001) and at T0-T2 3.78±2.26 (p=0.04) and mean increase in lower anterior facial height at T0-T1 is 2.18±1.75 (p<0.001) and at T0-T2 2.69±1.36 (p=0.03). there was statistically significant decrease in Jaraback's ratio was found. Mean decrease in Jaraback's ratio at T0-T10.87±1.92(p=0.012) and at T0-T2 1.08±1.36(p=0.05). This finding is in accordance with

studies done by Clark[3], Illing et a1[7], Lund and Sandler[14], Mills and McCulloch[13], Toth and McNamara[15] Sidlauskas A, Lee RT et al[10] Due to clinically significant rotation of mandible in clockwise direction, there is decrease in overbite and increase in facial height (mainly lower anterior facial height) which is a desirable outcome in Class II Division 1 patients having deep bite and reduced lower anterior facial height. McNamara has shown that every millimeter of increased lower anterior facial height camouflages a millimetre of mandibular length increase by causing the chin point to rotate downward and backward.

Dentoalveolar changes

There is decrease in upper incisors proclination. Mean decrease in U1-SN, U1-NA (mm) and U1-NA(°) at T0-T1 is 6.10±3.40(p=0.01), 3.24±1.61(p=0.01), 3.48±6.29(p=0.01) respectively. There was significant decrease in U1-SN, U1-NA(mm) at T1-T2 is 2.97±1.85(p=0.04) and 1.02±1.5(p=0.02). The position of lower incisors in Class II correction with functional appliances is critical. Excessive labial tipping of lower incisors should be limited as it reduces the potential for orthopedic change. Some authors reported significant lower incisor proclination during treatment with Twin Block appliance: Lund and Sandler[14] -7.9°, Mills and McCulloch[13] - 5.2°. Some studies, as this study, found that lower incisor remained comparatively stable after Twin-Block therapy (Trenouth[16] reported 1.4°, Toth and McNamara[15] by 2.8°, Sidlauskas A by 3.2°). A significant increase in the linear distance of lower incisor to facial plane is seen which is in accordance with the findings reported by Illing et a1[7] Lund and Sandler[14,] Mills and McCulloch[13] and could be attributed due to some increase in IMPA and additionally by downward and backward rotation of mandible. In present study there is significant Increase in IMPA, L1-NB(mm) and L1-NB(°). Mean increase at T0-T1 for IMPA is 6.81±3.74°(p=0.023), L1-NB(mm) is 2.36±2.65(p=0.23), L1-NB(°) is 2.61±1.82(p=0.46).

Conclusion

Twin block is one of the most popular removable functional appliances with good patients compliance compared to other removable functional appliance used for treatment of class 2 div 1 malocclusion in growing individuals. In present study, facial changes with Twin block appliance followed by fixed mechnotherapy is evaluated using lateral cephalogram at different intervals. With Twin block there is significant increase in Z angle and decrease in H angle which suggest that forward positioning of soft tissue pogonion and so that there is decrease in facial convexity and improvement in facial profile is seen. Correction in class 2 skeletal pattern is due to increase in mandibular length and forward positioning of mandible. Along with these skeletal changes there are improvement in dental relationship and soft tissue profile. Overlying soft tissues changes along with underlying hard tissues, which improves overall facial esthetics. So treatment with twin block appliance followed by fixed mechanotherapy improves patient's oral function as well as facial appearance.

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Table 1

SR. NO.	PARAMETERS	TO-T1		P VALUE	T1-T2		P VALUE	TO-T2		P VALUE
		MEAN	SD		MEAN	SD		MEAN	SD	
1	NASOLABIAL ANGLE	-0.04	1.65	0.525	0.64	0.58	0.92	-0.04	1.88	0.51
2	SOFT TISSUE FACIAL ANGLE (FH-N'Pog')	5.01	2.25	P<0.001	0.54	0.50	0.70	5.01	2.28	P<0.001
3	H ANGLE(N' Pog'- Pog'Ls)	-1.42	1.45	P<0.001	-0.15	0.60	0.15	-1.42	1.22	P<0.001
4	LOWER SULCUS TO H LINE	0.2	0.26	0.084	-0.19	0.20	0.69	0.2	0.25	0.98
5	Sn- H LINE	-0.26	0.13	0.057	-0.12	0.13	0.47	-0.26	0.15	0.03
6	UL-E LINE	0.23	0.12	0.052	0	0.11	0.90	0.23	0.12	0.10
7	LL- E LINE	0.33	0.25	0.178	0.03	0.07	0.47	0.33	0.26	0.07
8	UL-S LINE	0.26	0.25	0.240	0.08	0.43	0.05	0.26	0.49	0.35
9	LL- S LINE	0.57	0.46	0.032	0.07	0.24	0.10	0.57	0.41	0.01
10	Z ANGLE	3.22	1.77	P<0.001	0.12	0.38	0.16	3.22	1.83	P<0.001
11	SNA	-0.39	0.94	0.090	-0.03	0.67	0.99	-0.39	0.76	0.53
12	SNB	2.68	0.93	P<0.001	0.2	0.56	0.71	2.68	1.16	P<0.001
13	SND	2.44	0.98	P<0.001	0.38	1.04	0.15	2.44	1.27	P<0.001
14	ANB	-3.06	1.06	P<0.001	-0.23	0.37	0.09	-3.06	1.05	P<0.001
15	WITS	-3.07	0.65	P<0.001	-0.06	0.22	0.41	-3.07	0.65	P<0.001
16	SADDLE ANGLE	-3.69	4.25	0.016	-6.21	25.02	0.03	-3.69	24.10	0.04
17	ARTICULAR ANGLE	-1.33	2.13	0.068	0.05	1.23	0.16	-1.33	2.11	0.09
18	GONIAL ANGLE	3.64	1.46	0.020	-0.79	1.84	0.28	3.64	1.54	0.04
19	U.A.F.H.	0.61	1.27	0.051	0.49	0.60	0.07	0.61	1.33	0.52
20	L.A.F.H.	2.18	1.75	P<0.001	0.51	0.81	0.30	2.18	1.36	0.03
21	ANT. FACIAL HIGHT	2.79	2.47	P<0.001	1	1.06	0.41	2.79	2.26	0.04
22	POST. FACIAL HEIGHT	0.9	1.42	0.067	0.39	0.70	0.08	0.9	1.26	0.07
23	JARABACK'S RATIO	-0.87	1.52	0.012	-0.21	0.85	0.08	-0.87	1.36	0.05
24	FACIAL CONVEXITY	-3.05	2.43	P<0.001	-1.44	0.54	0.06	-3.05	2.10	P<0.001
25	CO-A	1.74	1.12	0.091	0.27	0.35	0.24	1.74	1.16	0.0
26	CO-B	1.67	1.50	P<0.001	0.2	0.43	0.51	1.67	1.63	P<0.001

Table 2

SR. NO.	PARAMETERS	TO-T1		P VALUE	T1-T2		P VALUE	TO-T2		P VALUE
		MEAN	SD		MEAN	SD		MEAN	SD	
27	DIFFERENCE CO-A & CO-B	-3.41	0.96	P<0.001	-0.06	0.32	0.03	-3.41	0.96	P<0.001
28	GO-GN	0.47	13.09	0.877	3.32	13.04	0.17	0.47	1.70	0.03
29	U1-NA(°)	-4.5	5.67	0.054	-1.02	1.50	0.02	-4.5	6.29	0.01
30	U1-NA(mm)	-2.84	1.70	0.010	-0.4	1.31	0.09	-2.84	1.61	0.01
31	L1-NB(°)	2.61	1.82	0.046	-0.96	1.36	0.05	2.61	0.50	0.01
32	L1-NB(mm)	2.36	2.65	0.023	0.43	0.52	0.07	2.36	2.16	0.07
33	U1-SN	-3.13	3.13	0.540	-2.97	1.85	0.00	-3.13	3.40	0.01
34	IMPA	5.81	3.74	0.023	-3	2.59	0.07	5.81	3.16	0.51