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En Masse Distalisation of Maxillary Arch Using TADs (IZC); Passive Self-Ligating Appliance v/s Clear Aligner – A Comparative Cephalometric Study

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ABSTRACT

Introduction: The treatment for patients with mild skeletal maxillary excess can be camouflaged by distalisation of the entire maxillary arch. This study compares the efficacy of aligners and passive self-ligation appliance to achieve en masse maxillary arch distalisation using infrazygomatic crest miniscrews.

Materials and methods: 12 patients indicated for distalisation with infrazygomatic crest miniscrews were selected. Group 1 (n=6) was bonded with passive self-ligation appliance. Group 2 (n=6) used clear aligners for treatment. Cephalometric software was used to compare the pre and post distalisation readings in the individual appliances for quantifying the amount of distalisation.

Results: Aligners demonstrated more retraction of the upper incisors. .

Conclusion: Both the appliances are effective in en masse maxillary distalisation. Dental parameters demonstrated aligners having better control in distalisation.

Key words: Infra zygomatic crest screws, TAD, Self-ligation appliance, aligners.

INTRODUCTION

Class II malocclusions are frequently observed in orthodontic practice and are characterized by a mesial relationship of the maxillary arch to the mandibular arch, because of skeletal or dental factors or a combination. The treatment for patients with Class II Division 1 malocclusion with mild skeletal maxillary excess can be camouflaged by distalisation of the entire maxillary dentition. In the past headgears were used for distalisation. [1] Temporary anchorage devices (TADs) have become an omnipresent component of contemporary orthodontic treatment mechanics and overcome the drawbacks associated with conventional methods of distalisation especially in adults. Also known as mini-implants or mini-screws, these small skeletal anchors have expanded the scope of orthodontics, providing a wider range of nonsurgical, nonextraction, and noncompliance treatment options ,thereby providing "absolute" anchorage.[2]

Infrazygomatic crest (IZC) miniscrews; serve as an alternative treatment option for patients who require orthognathic surgery by assisting in full-arch distalisation. Wu et al[3] reported 4.3mm incisor retraction and 3.1mm molar distalisation with IZC and passive self-ligation brackets in 20 adult patients. Studies[4] also recommended use of passive self-ligating system over conventional brackets as it provides more freedom between the wires and the brackets for sliding mechanics in distalisation. For adult Class II correction passive Self-ligation appliance in combination with Temporary anchorage devices (TADs) has been a well-established combination for achieving maxillary arch distalisation.

In the last decade, increasing numbers of adult patients have sought orthodontic treatment and expressed a desire for esthetic and comfortable alternatives to conventional fixed appliances. Due to this demand, orthodontic treatment with clear aligners is quickly gaining popularity. Ravera et al[5] have shown the possibility of obtaining Class II correction with a sequential maxillary molar distalisation in non-growing subjects. However, the use of clear aligners with TADs is still an evolving treatment plan to be adopted by orthodontists.

The purpose of this study was to quantify the treatment effects of

maxillary en-masse distalisation with IZC by passive self-ligation appliances or aligners in non-extraction class II division I adult cases by analysing the pre and post distalisation cephalometric radiographs for soft tissue, skeletal and dental changes in each group and also between both the groups. Hence, this study was aimed at helping the clinician understand which appliance is more suitable for en masse maxillary distalisation.

AIM

This study is designed to compare the cephalometric changes following en masse maxillary arch distalisation using passive self-ligation appliance v/s clear aligner treatment with TADs in Angle's Class II division 1 patients.

OBJECTIVE:

1. To analyse the pre and post cephalometric changes of en-masse maxillary arch distalisation using clear aligners and TADs.
2. To analyse the pre and post cephalometric changes of en masse maxillary arch distalisation using passive self-ligation appliance and TADs.
3. To compare the skeletal, dental and soft tissue changes between the two groups.

MATERIALS AND METHODS

MATERIALS

Orthodontic materials like Passive self- ligation brackets, Clear aligners, Clear Aligner adhesive , Infra zygomatic crest TADs , class I Elastics and Cephalometric software: Nemoceph Nx 2004 software

METHODOLOGY

The present study was prospective and comparative in nature. It involved 12 patients who were to undergo Maxillary enmasse distalisation. The sample size was calculated using the G power software. The power of the study was taken to be 80% and Confidence Interval (C.I.) of 95% was taken. The sample size was estimated to be a minimum of 6 for each group i.e Aligner and passive self-ligation.

All the subjects met the following criteria for case selection : (1) Patients above the age of 18 years, (2) Patients with Angle's Class II division I malocclusion with pleasing profile indicated for maxillary arch distalisation, (3) Good patient compliance during the treatment with good oral hygiene.

The subjects having the following conditions were excluded from the study (1) Patients with transverse dental or skeletal discrepancies.(2) Patients indicated for extraction treatment (except for third molars) or unilateral distalisation treatment (3) Patients showing signs and/or symptoms of temporomandibular disorders (TMDs) , (4)Patients having periodontal disease.

Treatment records including study models, cephalometric radiographs and photographs were made pre and post enmass distalisation. All patients were informed and explained about the study and the informed consent for participation and treatment was obtained.

In group 1 the teeth were bonded with passive self- ligating brackets , 0.022 slot .[11] After levelling and alignment was completed 19 x 25 stainless steel wire was inserted as the working wire. Distalisation was commenced by insertion of TADs (2 x 12 mm) at infra zygomatic crest and long hooks were attached to the arch wire between the lateral and canines on either side where the distalising force was applied.

In group 2 the aligners were changed at an interval of 2 weeks. After the first 4 aligners when the patient was accustomed to the aligner wear, TADs were inserted at the infra zygomatic crest by the appropriate technique. Buttons were attached distal to the lateral incisors to the clear aligners with the aligner bond adhesive were the distalising force was applied.

10 – 12 Oz of force (heavy class I elastic) were used to distalize the maxillary arch using IZC TADs to the hook/ button. The elastics were changed by the patient daily.

CEPHALOMETRIC ASSESSMENT

Assessment of the soft tissue, skeletal and dental changes using superimposition cephalometric software were done between pre and post – distalisation lateral cephalographs as illustrated in Figures (3-5) reported by Ghosh and Nanda [6].When a double image was present, the midpoint between two points was taken. The centroid point, the midpoint on a horizontal line between greatest mesial and distal convexity of the crowns, was used for dental linear measurement. To determine the amount of horizontal movement of maxillary teeth, the pterygoid vertical plane (PTV) [7] was used. The vertical movement of the maxillary teeth was determined from the palatal plane (PP). Angular changes of tooth position were determined by inclination of the long axes of the teeth to the sella-nasion plane (SN) in the maxillary arch. .

Following parameters were assessed :-

- Soft tissue :Upper lip to E-line (mm) , Lower lip to E-line (mm)
- Skeletal (mm): PTV-point A, PTV- point B, ANS-Me

  Dental-angular (degrees) : SN-U1,SN-U6, SN-U7

Dental-linear (mm): PTV-U1, PTV-U6,PTV-U7, PP-U1, PP-U6, PP-U7

(PTV – Pterygoid vertical , ANS- anterior nasal spine, Me – menton , SN- sella nasion plane , U1- maxillary central incisor, U6 – maxillary first molar, U7- maxillary second molar, PP- Palatal Plane).

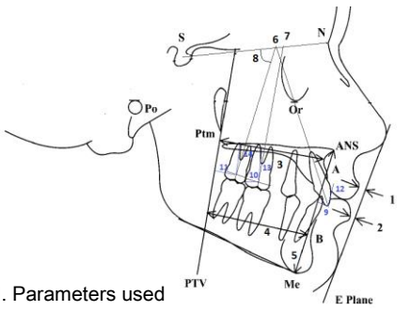


Figure 1. Parameters used

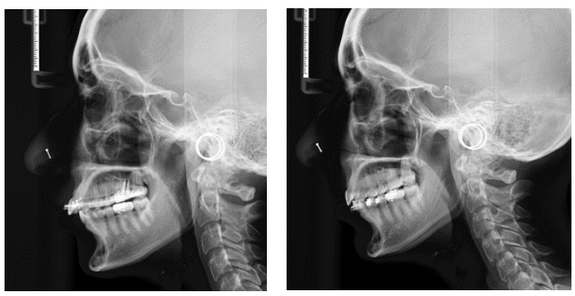


Figure 2: Lateral cephalographs pre and post distalisation

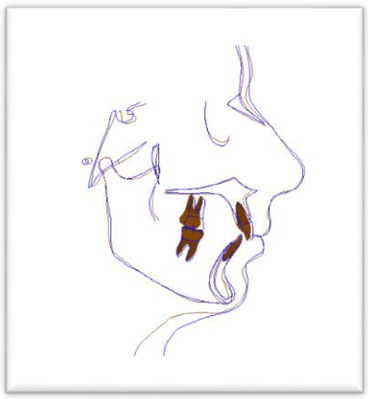
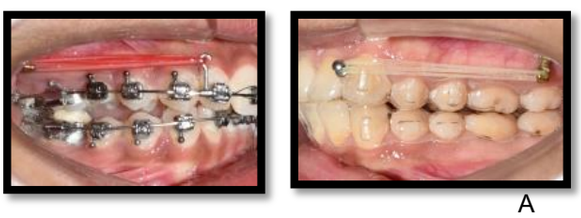


Figure 3: pre and post distalisation superimposition.



A

B

Figure 4: pre and post distalisation intraoral photographs. A: self-ligation group, B : Aligner group

RESULTS

The data was entered into Microsoft Excel spreadsheet and was checked for any discrepancies. Summarized data was presented using Tables and Graphs. The data was analysed by SPSS (21.0 version). Shapiro Wilk test was used to check which all variables following normal distribution. Parametric test: Independent t test (for two independent groups) and paired t test (two dependent groups) was used. Level of statistical significance was set at p-value less than 0.05.

In passive self-ligation Group non-significant retraction is observed from pre to post distalisation upper lip to E line (0.66 ±1.16) & lower lip to E line (1.23 ±2.01) as seen in Table 1 . The aligners Group also showed non-significant retraction of upper to E line (1±0.83) and lower lip to E Line(1.08 ±0.81) from pre to post distalisation as depicted in Table 2.. The inter Group comparison (Table 3) shows no significant difference between the upper lip and lower lip to E line. So both the appliances gave similar soft tissue changes

There was significant improvement in point A position as measured by PTV to point A (Table 1 and 2) in both appliances. In Group1 point A was retracted by 1.89 ±0.66 mm and in Group 2 it was retracted by 2.26 ±0.72mm. However in both the Groups, no significant difference was seen in PTV- point B and ANS- Me post distalisation. When the passive self-ligation Group was compared to aligners Group for skeletal changes it was found that both appliances performed similarly (Table 3)

Both self-ligation and aligners Groups showed significant difference post intervention in inclination of incisors and molars i.e. SN-U1, SN-U6 and SN-U7 as shown in Table 1 and 2. There was reduced proclination of incisors and distal tipping of molars. Upper incisor inclination (SN-U1) reduced by 8 ±6.81 degree in Group 1. In Group 2 the inclination reduced by 1.20± 0.4 degree. When both the Groups were compared, Significant difference was seen in SN- U1 and SN- U6 parameters with more tipping in self-ligation Group but no significant difference was found in SN-7 (Table 3).

In Group1 and Group 2, all the Dental linear parameters (PTV-U1, PTV-U6, PTV-U7, PP-U1, PP-U6, and PP-U7) were found to be significantly changed. (Table 1 ,2)

Retraction of upper incisors and distalisation of both upper and second upper molars was significant statistically. Incisor retraction of 2±4.75 mm and 2.8±5.88 mm was seen in passive self-ligation and aligners respectively. Distalisation of the first molar in passive self-ligation was observed as 3.8 ±1.16 mm and in clear aligners as 3.2 ±0.43 mm. Second molar is distilised by 3.4 ±2.05 mm in passive self-ligation and 3.08 ±`1.68mm in clear aligners.

In the vertical axis extrusion of incisors and intrusion of molars was observed. The maxillary incisors were extruded by 2.66±1.21 in the passive self-ligation group and 1.05mm in aligner group. In group 1 first molar is intruded by 2.5 ±1.64mm and second molar is intruded by 2.5±2.34mm. In group 2 first molar is intruded by 0.93 ±0.16mm and second molar is intruded by 1.16±0.1 mm.

Between both the appliances (Table 3) aligners demonstrated more retraction of the upper incisors PTV-U1. The self –ligation Group showed significant extrusion in the maxillary incisors as quantified by PP- U1 and significant intrusion of the first molars was quantified by PP- U6. Hence group 1 showed more clockwise rotation of occlusal plane. Rest all the dental linear parameters PTV – U6, PTV – U7, PP- U7 failed to reach the level of statistical significance.

DISCUSSION

Infrazygomatic crest miniscrews for en masse distalisation is an effective treatment tool to correct Class II malocclusions. Since the preliminary outcomes achieved by clinical cases are rather optimistic, this study has been conducted to verify and quantify the same. In this study IZC miniscrews were used in accordance to the studies conducted by Lin[4] and Lee S[8] to ensure bicortical engagement and 10-12 Oz (284-340g) of distalising force, this present study used 300g of force for distalisation by class I elastics.

Parameter	Predistalisation		Postdistalisation		Change		P value
	mean	Sd	mean	sd	mean	sd	
Soft tissue(mm)							
Upper lip to E line	-0.60	1.33	-1.27	1.06	0.66	1.16	0.073 NS
Lower lip to E line	0.49	2.03	-0.73	1.53	1.23	2.01	0.058 NS
Skeletal(mm)							
PTV –point A	52.11	0.90	50.22	1.14	1.89	0.66	0.023 S
PTV – point B	53.70	1.32	55.40	1.31	-1.7	0.23	0.112 NS
ANS-Me	77.81	0.66	78.53	0.51	-0.72	0.33	0.213 NS
Dental-angular (˚)							
SN-U1	107.33	8.23	99.33	11.65	8.00	6.81	0.010 S
SN-U6	62.16	1.85	54.75	1.21	7.14	1.5	0.004 S
SN-U7	68.16	11.32	56.16	7.16	12.00	4.97	0.014 S
Dental –linear (mm)							
PTV –U1	49.00	7.07	47.00	5.87	2.0	4.75	0.012 S
PTV- U6	21.60	4.96	17.83	4.21	3.83	1.8	0.003 S
PTV- U7	12.00	3.63	8.58	1.74	3.41	2.05	0.035 S
PP- U1	24.16	3.43	26.83	2.63	-2.66	1.2	0.003 S
PP- U6	15.50	1.97	13.00	1.67	2.50	1.64	0.010 S
PP-U7	13.83	2.22	11.33	0.51	2.50	2.34	0.014 S

Table 1- cephalometric changes at pre-distalisation and post distalisation in passive self-ligation appliance (n=6)

Insignificant soft tissue improvement was found in protrusion of both upper and lower lips as depicted by upper lip and lower lip to E line values (Table 1,2) in both the appliances and both

appliances giving similar results. (Table 3). TADs assisted en masse distalisation prevents round-tripping of the incisors[9] and there is no force to move the anterior teeth forward as they do not retract the incisors by taxing the anchorage as seen in conventional distalisation appliances which lead to mechanics which are only suitable for hypodivergent faces IZC distalization can be used also for hyperdivergent patients. This fact was also supported by the dental changes achieved by the study where the upper molars were found to be intruded post distalisation.

Parameter	Predistalisation		Postdistalisation		Change		P value
	mean	Sd	mean	sd	mean	sd	
Soft tissue(mm)							
Upper lip to E line	-0.83	0.24	-1.83	1.05	1.00	0.83	0.126 NS
Lower lip to E line	0.80	0.65	-0.28	1.42	1.08	0.81	0.09 NS
Skeletal(mm)							
PTV –point A	53.03	1.49	50.77	1.45	2.26	0.72	0.031 S
PTV – point B	52.23	0.77	53.33	0.65	-1.1	0.31	0.439 NS
ANS-Me	77.78	0.63	77.84	0.37	-0.06	0.35	0.522 NS
Dental-angular (˚)							
SN-U1	114.58	5.73	113.38	6.04	1.20	0.40	0.010 S
SN-U6	62.33	2.16	59.66	1.03	3.33	1.75	0.043 S
SN-U7	67.10	5.39	61.59	7.89	5.51	5.88	0.014 S
Dental –linear (mm)							
PTV –U1	60.20	2.44	57.39	6.54	2.80	5.88	0.023 S
PTV- U6	24.88	1.69	21.61	1.78	3.27	0.43	0.003 S
PTV- U7	15.12	0.70	12.04	1.84	3.08	1.68	0.035 S
PP- U1	25.50	5.32	26.55	5.20	-1.05	0.85	0.012 S
PP- U6	20.15	3.29	19.21	3.36	0.93	0.16	0.010 S
PP-U7	13.33	1.21	12.17	0.98	1.16	0.40	0.014 S

Table 2 - cephalometric changes at pre-distalisation and post distalisation in Clear aligners appliance (n=6)

protrusion of the lips .

There was a significant decrease in PTV-point A with a non-significant increase in point B which depicts the correction of dentoalveolar class II pattern (Table 1,2). This was due to retraction of maxillary incisors leading to remodelling of subspinale area. It was noted that on comparing which appliance gave better skeletal changes, there was no difference in skeletal changes achieved by both appliances during distalisation.

In our study although the full dentition of the maxilla was distalized, the intrusion of the posterior teeth prevented the wedging effect. In both the groups the lower facial height change was statistically insignificant. This was contrary to convention distalisation methods which showed extrusion of the posteriors and hence increase in anterior facial height. Hence it was inferred unlike conventional distalisation

Distalisation with significant correction of inclination in maxillary incisors and distal tipping of molars were observed in both the appliances (Table 1 and 2) More distal tipping was seen on the second molars than on the first molars. Table 3 demonstrated statistically significant intergroup differences in upper incisor inclination correction and upper first molar tipping with more tipping occurring in the self-ligation appliance compared to aligner in the incisors. This can be justified as the aligners envelope the complete tooth leading to more control in tipping[10] whereas the self-ligation brackets are placed attached to the labial surface during distalisation.

In the present study, significant retraction of incisors along with distalisation of molars was recorded in both the appliances. The distal movement of the maxillary first molar achieved was 3.8 mm in the self-ligation Group and 3.2mm in aligner Group as depicted by the PTV to centroid of Upper first molar. Whereas the distal

movement of the second molar shown by PTV to upper second molar centroid point achieved was 3.4 mm in self-ligation and 3mm in aligner. There was more distal tipping of first molar of 7.4 degree in self-ligation and 3 degree in aligners with a statistically significant difference between the two Groups as aligners have got better control of tipping during distalization The linear distal movement of the teeth were recorded from the incisal edge of the maxillary incisor and the centroid of the molars from Pterygoid vertical plane. Hence the linear measurements were also influenced by the amount tipping caused by distalisation. The results were similar to the study conducted by Sugawara et al[11] who reported that the average value of the first molar crown distalization was 3.6 mm using titanium anchor plates for maxillary dentition distalization. The maxillary dentition distalization can be considered more of distal tipping than bodily movement.

Table 3.

Parameter	Group 1		Group 2		P value
	Mean	sd	mean	sd	
Soft tissue (mm)					
Upper lip to E line	0.66	1.16	1.00	0.83	0.093 NS
Lower lip to E line	1.23	2.01	1.08	0.81	0.714 NS
Skeletal(mm)					
PTV –point A	1.89	0.66	2.26	0.72	0.833 NS
PTV – point B	-1.7	0.23	-1.1	0.31	0.324 NS
ANS-Me	-0.71	0.33	-0.06	0.35	0.446 NS
Dental angular (˚)					
SN-U1	8.00	6.81	1.20	0.40	0.035 S
SN-U6	7.41	1.50	3.33	1.75	0.018S
SN-U7	12.00	4.97	5.51	5.88	0.066 NS
Dental – linear (mm)					
PTV –U1	2.0	4.75	2.8	5.88	0.17 NS
PTV- U6	3.80	1.16	3.20	0.43	0.298 NS
PTV- U7	3.41	2.05	3.08	1.68	0.765 NS
PP- U1	-2.66	1.21	-1.05	0.85	0.024 S
PP- U6	2.50	1.64	0.93	0.16	0.042 S
PP-U7	2.50	2.34	1.16	0.40	0.200 NS

In the vertical linear measurements statistically significant maxillary incisors extrusion and the molars intrusion was observed in both the appliances post distalisation (Table 1 and 2). It was found that first molar was intruded by 2.5mm in Group 1 and 0.93mm in Group 2 whereas second molar was intruded by 2.5 in Group 1 and 1.1mm in Group 2. Although the full dentition of the maxilla was distalized, the intrusion of the posterior teeth prevented the wedging effect and FH- Mn angle remained stable, hence leading to non-significant changes in ANS to menton values. In a similar study done by Oh et al [12], who reported that the maxillary posterior teeth were intruded by 1 mm after microimplant anchorage used for distalization of the posterior teeth. The increased amount of molar intrusion achieved in our study seemed to be due to the vertical position of the miniscrews and the level hooks attached to the archwire.

Hence both passive self-ligation appliance and clear aligners gave optimistic results for distalisation using infrazygomatic crest miniscrews. Aligners gave better control in tipping than passive self-ligation appliance during the process of en masse distalisation.

CONCLUSION

1. Both the appliances are effective in distalising the maxillary en masse.
2. There was more tipping movements in Passive self –ligation compared to aligners
3. Incisor extrusion and first molar intrusion was seen to be more in passive self-ligation appliance.
4. Dental parameters demonstrated aligners having better control in distalisation

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