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Results: Superimposition of pre- and post-treatment cephalometric tracings, showed an advancement of A-point and ANS towards an anterior-lower direction. Overbite increased significantly with treatment and caused significant changes in other skeletal and dentoalveolar variables.

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Daniel Celli [α], Alessandro De Carlo [σ], Enrico Gasperoni [ρ] & Roberto Deli [ω]

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Conclusion: The selected sample showed a variable skeletal relationship except for a marked anterior open-bite which underwent this treatment procedure. Despite these odds, the findings of this study suggest that openbite treatment with occlusal adjustment provides statistically significant results and clinically good stability over time.

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I. Introduction

Malocclusions characterized by anterior open bite are often difficult to treat successfully. Numerous theories have been proposed for aetiology of open bite, including heredity, unfavourable growth patterns, digit habits, enlarged lymphatic tissue function, health, and stability may occur with anterior open bite. These difficulties may include diminished dental aesthetics during speech and when smiling, lack of incisor guidance and canine disclusion, resulting in molar cuspal wear, exacerbation of temporomandibular dysfunction, lisping and involuntary spitting when speaking, posterior cross bite with functional shift of the mandible related to a posterior collapse of the maxilla, and maxillary incisor root resorption. [1,2,3]

Skeletal open bite is usually considered as a deviation in vertical relationship of the maxillary and mandibular dental arches with a lack of contact between opposing segments of teeth. If however, a dento-alveolar compensatory mechanism is involved, functi - onal occlusion can be reached.[4]

Therefore, orthodontic treatment consisted mainly of dento-alveolar changes and modification of oral habits. In case of unfavourable skeletal patterns, it could be necessary an orthognatic surgery correction.[5]

Unfortunately, many authors reported significant relapse of open bites treated either surgically or with orthodontic appliances. Skeletal changes greater than those observed in untreated adults have been noted beyond 1 year post-surgery in adult patients who had surgical correction of a long face deformity. [6,7]

Occlusal adjustment for the correction of anterior open bite is a therapeutic method already described and not very widespread in the literature. Few cases have been reported recently with an occlusal vertical correction, by grinding, along orthodontic therapy. Janson, Crepaldi et al. [2008] reported change in the occlusion, function and dentin sensitivity by occlusal adjustment on permanent teeth. Spena and

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Gracchus [2008] reported a vertical progressive reduction of the deciduous teeth with braces and functional exercises.

The aim of the present study was to evaluate the effect of deciduous teeth grinding during mixed dentition in the occlusion, by the control of permanent molars eruption, using contemporary maxillary expansion appliance and palatal grid to block the action of tongue muscles on dentoalveolar remodeling. Statistical analyses of the results and a 3 years follow-up were showed.

II. Material and Methods

A sample consisted of 31 patients (15 male, 16 female), was obtained from the files achieved during private practice in Pescara, Italy. All patients originally had an anterior open-bite malocclusion, with pre-treatment mean age of 9.09 years (SD 1.37, range 7 - 12). The mean age at the end of the treatment was 12.68 years (SD 1.58, range 11 – 15.5). All the patients were scheduled for a midterm follow-up at 3 years after treatment. At the time of drawing up this manuscript, 14 patients of the entire sample reached the 3 years follow-up. The occlusal adjustment procedure was performed in centric relation, according to the method of Okeson.[8] All patients signed an informed consent for the orthodontics treatment and the necessary follow-up.

a) Cephalometric Analysis

All cephalometric radiographs were realized at pre-treatment (T1), immediately post-treatment (T2), and after three year (T3). They were digitized in double-blind by two primary authors, using TopCeph® software analysis. The cephalograms were then verified for landmarks location and anatomic contours in order to eliminate any casual errors by the operators. All cephalometric easurements are described in Table I.

Table I : Cephalometric values used to evaluate the samples

Cephalometric measurements	
SNA	Angle between lines S-N and N-B
SNB	Angle between lines S-N and N-B
ANB	Angle between lines N-A and N-B
Wits	Distance between perpendicular projections of Points A and B on the functional occlusal plane
FMA	Frankfort mandibular plane angle: angle between lines Po-Or and Go-Me
Sn.GoGn	Angle between lines S-N and Go-Gn
Sn.anspns	Angle between lines S-N and ans-pns (maxillary plane)
anspns.GoGn	
Go geometric	Angle between posterior (Go-Ar) and lower borders (Go-Me) of the lower jaw
(+1)/anspns	Angle between long axis of upper incisor and ans-pns
(-1)/GoGn	Angle between long axis of lower incisor and Go-Gn
Overjet	Distance between incisal edges of maxillary and mandibular central incisors, parallel to Frankfort plane
Overbite	Distance between incisal edges of maxillary and mandibular central incisors, perpendicular to occlusal plane
Interincisal angle	*Angle* formed by long axis of the upper incisor and long axis of the lower incisor

Any disagreements were solved by retracing the landmark or structure to the mutual satisfaction of both operators.

b) Inclusion Criteria

In 31 patients presented to clinic observation the initial examination revealed an 100% of anterior open bite, a 62% of mouth breathing, 55% of muscle deficit and 70% of lip incompetence at rest. The sample showed different skeletal relationship: 33.3% class III, 26.7% class II and 40% class I. The patient's long-standing tongue-thrust habit had contributed to an anterior open-bite up to - 7 mm and an over-jet up to 9 mm. The patient maintained good oral hygiene and showed no evidence of periodontal disease.

c) statistical analyses

All data were entered into spreadsheet Office Excel 2007 (Microsoft Corporation. Redmont, Washington State) and processed to calculate the mean, median, standard deviation, minimum value, maximum value. To compare the pre-treatment, post-treatment cephalometric changes, dependent t tests were used. The follow up cephalometric values were compared only among the small sample size (n=14) for the post-treatment and 3 years after treatment. The level of significance was 5%. These analyses were performed with PhStat 2 software (statistic add-in Microsoft Excel, version 2.7, Prentice Hall, Inc., Pearson Education).

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III. Treatment Plan

Treatment objectives aim to correct the anterior open bite and achieve ideal overbite and overjet, correct the transversal discrepancy of the two dental arches increasing the space for the future permanent teeth, and achieve a correct Class I dental relationship.

A rapid palatal expander HYRAX type is inserted between the second deciduous molars and canines. The active arms of the appliance are extended to the canines, embraced them, with cannulas for the insertion of a lingual grid at the end of the activation.

During the period of RME treatment, the deciduos molars are ground with a diamond bur, to anticipate and control the contemporary eruption of the permanent first molars, and thus, the vertical dimension.(Fig.1)

Figure 1 : Occlusal grinding of the deciduos teeth and Rapid maxillary expansion during treatment

The expansion time was 3.4 to 4 weeks. A lingual grid was positioned just after the rapid maxillary expansion to prevent the wrong lower tongue posture and allow subsequently the setting up of an oral seal during deglutition. The rapid maxillary expansion was kept for six months of retention.

IV. Treatment Progress

After the treatment was suspended, maxillary and mandibular arches were bonded with an HSDC (hybrid system Daniel Celli), an hybrid straightwire appliance: anterior conventional brackets (STEP, Leone® s.p.a, Florence, Italy) and posterior passive self ligating brackets (F1000, Leone® s.p.a, Florence, Italy). If necessary strategic brackets positioning was used. A .014" or 016" nickel titanium main archwire was placed for initial alignment depending on the degree of dental crowding. Over the next seven/nine months, the arch - wires were generally stepped up to .016x.025 HANT, .019" x .025" HANT (heat activated nichel titanium), .020" Australian stainless steel, .019" x .025" stainless steel wire. Intermaxillary elastics were used with the last leveling arch wire to correct the occlusion and the dental open bite. The case was finished with a sectional arch wire .019" x .025" stainless steel on the maxillary arch and a .016" Ni-Ti on the lower arch, with intermaxillary elastics worn to maintain the correction. (Fig. 2)

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Figure 2 : Treatment progress with nickel titanium main archwires and anterior open bite closing during the treatment

V. Results

At the end of active treatment, the brackets were debonded, and a fixed retainer was placed on the lower anterior arch, while a wraparound removable retainer, for the upper dental arch was delivered. The mean time of active treatment was 3.22 years (SD, 0.93). Post-treatment facial and intraoral photographs showed good aesthetic, skeletal balance and good functional results in all the patients. Final occlusal results, dento-alveolar compensation and root angulations were acceptable, with an adequate overjet and overbite. Superimposition of pre- and post-treatment cephal - ometric tracings, showed an advancement of A-point and ANS towards an anterior-lower direction.

The pre-treatment overbite had a mean value of -2.5 mm (SD - 2.22, median – 2, range -7 to 0) while post-treatment overbite had a mean of 1.75 mm (SD 1.75, median 1.75, range 0 to 3). Overbite increased significantly with treatment and caused significant changes in other skeletal and dentoalveolar variables. In fact there was a mean increase in overbite after the therapeutic protocol used of 4.25 mm (SD 2.58, median 3.5, range -0.5 to 7.5) The dependent t test analysis confirmed the statistically significant of the results sho - wed (t test 0,000137, $P < 0.05$). There was a statistically significant increase in other dentoalveolar cephalometric values (-1/GoGn; interincisal angle); the vertical facial pattern variables, specially the maxillary plane (SN/anspns; anspns/GoGn), had statistically significant reductions. Starting from the dentoalveolar pattern, the pre-treatment -1/GoGn changed from an average of 95.00 (SD 9.64, Median 93, range 76 to 114) to an average of 91.63 (SD 9.54, Median 94, range 70 to 104). The pre-treatment interincisal angle mean was 118.5 (SD 11.689, Median 121, range 98 to 138) while the mean value after treatment was 123.5 (SD 8.691, Median 124.5, range 116 to 145) (Table II). Upon the whole sample, 30 patients had a positive overbite after the therapeutic protocol whereas 1 had a negative overbite (3.23% of the patients) due to the lack of patient cooperation and therefore, he was excluded from the statistical analysis. The mean changes of the other variables and their standard deviations are also shown on Table III. After 3 years of follow-up, the sample (n=14) showed minimal changes in cephalometric values chosen, as confirmed by the statistical results shown on Table IV. Of the 14 patients treated, five repo-rted almost the same values as at the end of treatment.

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Table II : Cephalometric results before and after treatment calculated by the Mean, Median and Standard Deviation (sample n=30)

	Before Treatment			After Treatment		
Cephalometric measurements	Mean	Median	SD	Mean	Median	SD
SNA	81,141	81	4,063	81,090	81	4,437
SNB	77,883	77,75	3,892	78,272	77	4,557
ANB	3,266	4	2,237	2,818	3	1,453
Wits	-2,091	-2,05	3,368	-2,163	-2,5	2,806
FMA	29,85	29	5,139	31	31	5,196
Sn.GoGn	38,641	39,35	5,989	38,272	38	5,178
Sn.anspns	6,716	8,5	3,461	8,6	10	3,388
anspns.GoGn	32,083	31,5	4,010	30,6	31	4,753
Go	132,5	131	5,435	131,273	128	6,679
(+1)/anspns	113,167	112,5	6,912	113,545	115	3,939
(-1)/GoGn	95,008	93	9,644	91,636	94	9,542
Overjet	3,291	3,5	2,879	2,863	3	1,266
Overbite	-2,5	-2	2,225	1,75	1,75	1,138
Interincisal angle	118,5	121	11,689	123,5	124,5	8,691

Table III : Cephalometric changes before and after treatment and results of dependent t tests (P< 0.05)

	Change before-after			
Cephalometric measurements	Mean	Median	SD	*P*
SNA	0,05	0	0,373	0,6778
SNB	0,389	0,75	0,664	0,37941
ANB	0,448	1	0,783	0,58042
Wits	0,071	0,45	0,562	0,87619
FMA	1,15	2	0,056	0,35907
Sn.GoGn	0,368	1,35	0,81	0,40987
Sn.anspns	1,883	1,5	0,073	0,02875*
Anspns.GoGn	1,483	0,5	0,743	0,0483*
Go	1,227	3	1,244	0,63869
(+1)/anspns	0,378	2,5	2,972	0,81503
(-1)/GoGn	3,371	1	0,102	0,03909*
Overjet	0,428	0,5	1,61	0,45294
Overbite	4,25	3,5	2,58	0,000137*
Interincisal angle	5	3,5	2,997	0,04786*

Table IV : Cephalometric results at the end of the treatment and after 3 years of follow-up (sample n=14)

	After Treatment			Follow-up 3 years		
Cephalometric measurements	Mean	Median	SD	Mean	Median	SD
SNA	77	77	1,632	77,25	77,5	1,707
SNB	74,625	74,75	2,286	74,75	75	2,217
ANB	2,375	2,5	1,108	2,5	2,5	1,29
Wits	-2,95	-3,4	2,23	-2,25	-2	2,217
FMA	28,75	29	2,986	28,175	27,85	3,374
Sn.GoGn	40	39,5	3,162	39,05	38,5	4,18
Sn.anspns	11,525	10,8	2,025	11,25	11,5	0,957
anspns.GoGn	29,15	29,8	3,875	29,1	29,2	3,583
Go	130,5	130,5	5,8	130	130	5,77
(+1)/anspns	115,375	116,5	2,625	115,75	116,5	2,629
(-1)/GoGn	94,25	94,5	1,707	95,975	96	1,862
Overjet	2,75	3	1,258	2,75	3	1,258
Overbite	1	0,75	0,707	1,2	1,15	0,62
Interincisal angle	118	117	5,887	118	117	4,031

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VI. Discussion

The treatment protocol described for the open bite correction, is composed of a combination of progressive vertical reduction of the deciduous first and second molars and fixed appliance that requires minimal patient's compliance.

From the analysis of the treated patients, in almost all of them the therapeutic objectives were reached. The selected sample (n=30) showed a variable skeletal relationship except for a marked anterior open-bite that has been underwent this treatment procedure. Although these odds, related to subsequent different cephalometric sagittal markers, they can be considered indicative of the significant scientific value of the tested protocol that can be applied in any different subjects and clinical situations.

Rapid maxillary expansion (RME) is a universally employed technique for correction of posterior crossbites and gain in arch perimeter in patients with tooth-size/arch-size discrepancies, like skeletal Class II and Class III. [9] The device leads mainly skeletal and alveolar volume variations of the palate, with orthopedic effect of rapid expansion, and subsequently in selected cases, antero-posterior and vertical mandibular changes in skeletal Class II patients.[10]

Unfortunately a slight relapse occurs after device removal in long term, the greates being in intercanine width.[11]Mainly expansion stability could be due to three factors: young age of the patients, which led to a good orthopedic result, prolonged retention period, which permitted complete remineralization of the palatine suture, and repositioning of the tongue within the arches following an increase in upper diameter.[12]

Rapid maxillary expansion is an important treatment factor related to the open bite correction. It is also associated with a significant increment in nasal volumes and in the transverse diameter of the maxilla, with statistically significant increase respectively in decongested total nasal volumes and in binasal cavity. Regard to breathing posture, the role of this procedure still remains debatable.[13]

The anterior tongue rest posture plays an etiologic role in the relapse of anterior open-bite. [14]The open bite reduction and its stability can also be attributed to the tongue spurs, which interfere with the wrong lower tongue posture and with the establishment of an oral seal during deglutition.[15]

The effectiveness of the tongue spurs has been repeatedly the subject of criticism and literature review. Its effect changes, depending on various parameters

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such as length of spurs use, age of stakeholders, the skeletal class and function, design spurs. The tongue spurs force a change on the anterior tongue rest posture, which in turn allows incisors to erupt, closing the anterior open bite.[16]

The authors decided to perform occlusal adjustment only on deciduous molars. Grinding is an aggressive procedure for the dental tissues, with permanent effects on teeth. Working on deciduous teeth becomes a transitional and non-invasive procedure for the patient. The results confirmed previous studies demonstrating the efficacy of the procedure to close an open-bite.[17,18] Selective grinding, to be effective, must be achieved during the period of growth and, namely, at the moment of maxillary and mandibular permanent teeth eruption. A loss of occlusal contact between the upper and lower molars resulted at this time. The deciduous teeth will be ground up to that a physical contact would be re-establish with the antagonist molars.

The proper management of an open-bite patient is based on the choice of a therapeutic protocol that takes into account the difficulties and long-term stability of this treatment. Early treatment of open bite allows compensatory craniofacial growth and reduces the need for a second phase of treatment that might involve extractions or orthognathic surgery. When the open bite correction begins in deciduous or mixed dentition, as in the treatment protocol proposed, the appliances could be very effective and produce faster response in younger subjects.[19] Finally, the use of multiple therapeutic options allows us to get satisfactory and stable results over time, as demonstrated by the 3-years follow up.

Accordingly, it is important to notice the cephalometric changes after the therapeutic protocol. There was a statistically significant decrease of the facial pattern angles as well as the dento-alveolar terms. Ans-Pns plane rotate clockwise in the mid-sagittal plane. The upper and lower incisors change their position in order to close the bite; therefore a good aesthetic condition and the protection of incisors guidance during protrusion are kept over time.

Although after 3 years the study presents a small sample, it's already possible to identify a stable results, especially for five patients showing almost any change at the follow-up (Fig 3). It was interesting and relevant that larger over jets and tooth display (at rest) disappeared and got a natural harmony to patient's face.

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Figure 3 : Intra oral photographs before treatment, at the end of treatment and after 3 years

VII. Conclusion

This study suggests that selective grinding of deciduous teeth permits to obtain fast therapeutic results with harmless and transitory effects for dental tissue. Its action, coupled with the rapid expansion of the palate and tongue spurs, allows the closure of open bite, followed by orthodontics. The early treatment proposed of open-bite tendency results in a rapid control of the vertical dimension, in a significant and stable improvement of a correct and functional occlusion and in perceived facial aesthetic.

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