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CONTENTS

# Effects of the sander bite jumping appliance in patients with class ii malocclusion before growth peak

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**Sander bite jumping appliance (BJA) is a functional appliance used to correct Class II malocclusion in growing patients. The aim of this study was to identify the dento-skeletal effects in patients treated with BJA before growth peak and to compare these effects with the ones obtained in a similar group treated with the Andresen activator (AA). Twenty subjects with class II relationship of the skeletal bases and cervical vertebrae maturation stage 1 or 2 were enrolled in the study and treated with BJA. This group were compared to 14 subjects treated with AA. Cephalometric analyses were carried out using landmarks derived from the analyses of Pancherz, Ricketts, Tweed and Steiner. After treatment with BJA Pg/OLp increase was 7.40±3.81 mm (P<0.001); Pg/OLp+Co/OLp significantly heightened from T0 to T1 (T0: 82.20±4.65 mm vs T1: 89.62±4.27, P<0.001). Overjet (is/OLp - ii/OLp) significantly decreased from T0 to T1 (T0: 7.40±2.31 mm vs T1: 3.05±1.34 mm, P<0.001). Molar relationship improved passing from 1.46±1.68 mm at T0 to -3.56±2.04 mm at T1 (P<0.001). No statistically significant differences were found between BJA and AA groups at T0 and T1. BJA treatment determined a Class II malocclusion correction in all patients. The correction of molar relationship was mainly due to the increase in mandibular length; the correction of the overjet was due to the increase in mandibular length, to the slight pro-inclination of the lower incisors and the mild retro-inclination of the upper incisors. No significant differences were found in effectiveness between BJA and AA.**

Class II malocclusion affects one third of the Italian children (1). Several factors may contribute to the development of Class II malocclusion including skeletal pattern, soft tissues, dental factors and vicious habits. Animal studies showed that a forward positioning of the mandible increased condylar growth (2-3). The functional orthopedic appliances determine an advanced mandibular position by stretching the external pterygoid muscles: which favours mandibular growth (4).

Sander bite jumping appliance (BJA) is one of the most used functional orthopedic appliances: the main characteristic of this device is represented by two prongs embedded in the upper plate and positioned to form an angle of 60° with the occlusal plane. These force the patient to posture the mandible forward (5). In most studies related to the functional orthopedic treatment of Class II malocclusion, the therapy is performed during the patient's growth peak (6).

In our experience the treatment performed before growth peak can be beneficial because children are more cooperative than adolescents (7). The objectives of the study were: to identify the skeletal and dentoalveolar effects in patients treated with BJA before growth peak; to compare these effects with the ones obtained in a similar group treated with the Andresen Activator (AA).

*Key words: Class II malocclusion, Sander bite jumping appliance, Andresen activator, Cephalometric analyses*

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## MATERIALS AND METHODS

Twenty patients (11 males and 9 females; mean age: 10.2±1.6 years before treatment, T0) with the following characteristics were enrolled: bilateral class II molar relationship; overjet ± 5mm; class II skeletal relationship (ANB >4°); mandibular retrusion (SNB <78°); CS1 or CS2 cervical vertebral maturation stage according to Baccetti et al. (8). The exclusion criteria were genetic or endocrine diseases that could affect the treatment; previous orthodontic treatments; skeletal abnormalities (9). The documentation included: study models, extraoral and intraoral photographs, orthopantomography, lateral cephalograms before (T0) and after (T1) treatment. Class II malocclusion was diagnosed through clinical examination, lateral photographs, lateral cephalogram and Frankel maneuver at T0 (10-11). Patients were treated with BJA for a mean period of 12.2±2.3 months and were instructed to wear the appliance for at least 14 hours/day (12). At the end of the treatment dento-skeletal variables on the cephalometric traces of the initial (T0) and final (T1) lateral cephalograms were measured with Dolphin Imaging 11.7 software. Parameters derived from Steiner, Tweed, Ricketts, Pancherz and McNamara cephalometric analyses were measured to gather all the measurement variables often used in the literature (Table I) (13). The obtained data were compared with those of our previous study performed on 14 patients (7 males and 7 females) with Class II malocclusion treated with AA before the growth peak (7). The statistical analysis was performed using STATA software. Mean and standard deviation (SD) were calculated for all cephalometric variables at T0 and at T1. Paired t test was performed for the evaluation of the dento-skeletal changes that occurred during treatment with BJA. Unpaired t test was performed to compare the efficacy of BJA and AA. The p-value was considered statistically significant if less than 0.001.

## RESULTS

Skeletal and dentoalveolar measurements at T0 and T1 and their relative changes over time are reported in Table II. Pg/OLp and Pg/OLp+Co/OLp were significantly higher after BJA treatment (Δ Pg/OLp: 7.40±3.81 mm, P<0.001; Δ Pg/OLp+Co/OLp: 8.92±8.67 mm, P<0.001). Overjet (is/OLp -

**Table I**. *Skeletal and dentoalveolar variables*.

| *Variable* | *Unit of measurement* | *Description* |
|---|---|---|
| *is/OLp–ii/OLp* | mm | Overjet |
| *ms/OLp–mi/OLp* | mm | Molar relationship |
| *A/OLp* | mm | Position of the maxillary base |
| *Pg/OLp* | mm | Position of the mandibular base |
| *Co/OLp* | mm | Position of the condylar head |
| *Pg/OLp+Co/OLp* | mm | Sagittal mandibular lenght |
| *Co–Gn* | mm | Total mandibular lenght |
| *is/OLp–A/OLp* | mm | Position of the upper central incisor in the maxilla |
| *ii/OLp–Pg/OLp* | mm | Position of the lower central incisor in the mandible |
| *ms/OLp–A/OLp* | mm | Position of the upper permanent first molar in the maxilla |
| *mi/OLp–Pg/OLp* | mm | Position of the lower permanent first molar in the mandible |
| *SNA* | ° | Antero-posterior positioning of maxilla in relation to cranial base |
| *SNB* | ° | Antero-posterior positioning of mandible in relation to cranial base |
| *ANB* | ° | Relative position of the maxilla to mandible |
| *IMPA (L1_MP)* | ° | Incisor Mandibular Plane Angle |
| *FMIA (L1_FH)* | ° | Frankfort-Mandibular Incisor Angle |
| *FMA (MP_FH)* | ° | Frankfort-Mandibular plane Angle |
| *U1_SN* | ° | Inclination of maxillary incisor to anterior cranial base |
| *U1_L1* | ° | Interincisal angle |

ii/OLp) significantly decreased from T0 to T1 (T0: 7.40±2.31 mm vs T1: 3.05±1.34 mm, P<0.001). Molar relationship improved passing from 1.46±1.68 mm at T0 to -3.56±2.04 mm at T1 (P<0.001).

**Table II**. *Cephalometric values at T0 and T1 expressed as mean ± standard deviation. Significant values are in bold.*

| *Measurements* | *T0 (mean±SD)* | *T1 (mean ± SD)* | *ΔT1–T0 (mean±SD)* | *P-value* |
|---|---|---|---|---|
| *is/OLp–ii/OLp* | 7.40 ± 2.31 | 3.05 ± 1.34 | – 4.27 ± 2.05 | **<0.001** |
| *ms/OLp–mi/OLp* | 1.46 ± 1.68 | – 3.56 ± 2.04 | – 4.95 ± 1.96 | **<0.001** |
| *A/OLp* | 73.42 ± 3.67 | 77.63 ± 4.58 | 4.21 ± 4.12 | 0.011 |
| *Pg/OLp* | 77.15 ± 5.06 | 84.55 ± 4.33 | 7.40 ± 3.81 | **<0.001** |
| *Co/OLp* | 5.14 ± 1.83 | 5.09 ± 3.36 | – 0.05 ± 2.82 | 0.956 |
| *Pg/OLp+Co/OLp* | 82.20 ± 4.65 | 89.62 ± 4.27 | 8.92 ± 8.67 | **<0.001** |
| *Co–Gn* | 96.32 ± 5.26 | 105.53 ± 5.03 | 9.21 ± 8.57 | 0.008 |
| *is/OLp–A/OLp* | 9.66 ± 1.91 | 9.66 ± 0.1 | 0.10 ± 2.62 | 1 |
| *ii/OLp–Pg/OLp* | – 3.06 ± 4.04 | – 2.07 ± 2.92 | 0.16 ± 1.77 | 0.589 |
| *ms/OLp–A/OLp* | – 21.03 ± 1.33 | – 22.38 ± 2.51 | – 1.30 ± 2.79 | 0.164 |
| *mi/OLp–Pg/OLp* | – 27.7 ± 3.66 | – 27.79 ± 2.72 | 0.57 ± 3.21 | 0.787 |
| *SNA* | 80.05 ± 3.90 | 80.82 ± 4.05 | 0.77 ± 1.11 | 0.056 |
| *SNB* | 73.43 ± 3.38 | 75.95 ± 4.64 | 2.52 ± 2.41 | 0.009 |
| *ANB* | 6.62 ± 1.78 | 4.96 ± 2.42 | – 1.66 ± 1.33 | 0.003 |
| *IMPA* | 94.16 ± 6.38 | 97.96 ± 4.71 | 3.44 ± 5.82 | 0.094 |
| *L1_FH* | 59.90 ± 7.56 | 55.64 ± 6.07 | – 4.26 ± 5.88 | 0.048 |
| *MP_FH* | 25.66 ± 4.26 | 27.06 ± 4.55 | 1.40 ± 2.06 | 0.059 |
| *U1_SN* | 106.20 ± 10.15 | 101.23 ± 9.06 | – 4.97 ± 5.23 | 0.015 |
| *U1_L1* | 123.73 ± 11.98 | 124.45 ± 13.47 | 3.48 ± 12.23 | 0.392 |

**Table III**. *Comparison of cephalometric values between BJA group and AA group at T0 and T1.*

| *Measurements* | *BJA (n=20) AA (n=14)* | *T0 (mean±SD)* | *T0 p-value* | *T1 (mean ± SD)* | *ΔT1–T0 (mean ±SD)* | *T1 p-value* |
|---|---|---|---|---|---|---|
| *is/OLp – ii/OLp* | BJA | 7.40 ± 2.31 | 0.319 | 3.05 ± 1.34 | – 4.27 ± 2.05 | 0.416 |
| | AA | 8.21 ± 2.37 | | 3.39 ± 0.57 | – 4.16 ± 2.21 | |
| *ms/OLp – mi/OLp* | BJA | 1.46 ± 1.68 | 0.378 | – 3.56 ± 2.04 | – 4.95 ± 1.96 | 0.190 |
| | AA | 2.12 ± 1.79 | | – 2.50 ± 1.72 | – 4.62 ± 2.34 | |
| *A/OLp* | BJA | 73.42 ± 3.67 | 0.709 | 77.63 ± 4.58 | 4.21 ± 4.12 | 0.252 |
| | AA | 75.74 ± 15.31 | | 76.81 ± 5.99 | 1.07 ± 13.63 | |
| *Pg/OLp* | BJA | 77.15 ± 5.06 | 0.011 | 84.55 ± 4.33 | 7.40 ± 3.81 | 0.677 |
| | AA | 78.02 ± 5.99 | | 85.84 ± 8.91 | 7.82 ± 9.95 | |
| *Co/OLp* | BJA | 5.14 ± 1.83 | 0.668 | 5.09 ± 3.36 | – 0.05 ± 2.82 | 0.872 |
| | AA | 4.49 ± 2.45 | | 4.00 ± 1.75 | – 0.49 ± 2.48 | |
| *Pg/OLp + Co/OLp* | BJA | 82.20 ± 4.65 | 0.557 | 89.62 ± 4.27 | 8.92 ± 8.67 | 0.644 |
| | AA | 83.97 ± 6.63 | | 90.92 ± 7.97 | 7.25 ± 4.47 | |
| *Co – Gn* | BJA | 96.32 ± 5.26 | 0.959 | 105.53 ± 5.03 | 9.21 ± 8.57 | 0.407 |
| | AA | 96.47 ± 7.96 | | 106.53 ± 7.59 | 10.06 ± 5.35 | |
| *is/OLp – A/OLp* | BJA | 9.66 ± 1.91 | 0.581 | 9.66 ± 0.1 | 0.10 ± 2.62 | 0.621 |
| | AA | 10.07 ± 1.82 | | 9.11 ± 1.85 | – 1.75 ± 3.18 | |
| *ii/OLp – Pg/OLp* | BJA | –3.06 ± 4.04 | 0.483 | – 2.07 ± 2.92 | 0.16 ± 1.77 | 0.364 |
| | AA | –4.35 ± 4.49 | | – 4.33 ± 2.92 | – 0.22 ± 2.69 | |
| *ms/OLp – A/OLp* | BJA | –21.03 ± 1.33 | 0.537 | – 22.38 ± 2.51 | – 1.30 ± 2.79 | 0.978 |
| | AA | –21.56 ± 2.91 | | – 22.41 ± 3.36 | 0.98 ± 6.92 | |
| *mi/OLp – Pg/OLp* | BJA | –27.7 ± 3.66 | 0.813 | – 27.79 ± 2.72 | 0.57 ± 3.21 | 0.956 |
| | AA | –28.07 ± 3.69 | | – 27.89 ± 4.88 | 1.91 ± 8.47 | |
| *SNA* | BJA | 80.05 ± 3.90 | 0.230 | 80.82 ± 4.05 | 0.77 ± 1.11 | 0.971 |
| | AA | 81.9 ± 4.20 | | 80.76 ± 3.68 | – 1.49 ± 3.43 | |
| *SNB* | BJA | 73.43 ± 3.38 | 0.046 | 75.95 ± 4.64 | 2.52 ± 2.41 | 0.284 |
| | AA | 76.8 ± 4.51 | | 77.91 ± 3.26 | 0.82 ± 2.69 | |
| *ANB* | BJA | 6.62 ± 1.78 | 0.099 | 4.96 ± 2.42 | – 1.66 ± 1.33 | 0.021 |
| | AA | 5.1 ± 2.10 | | 2.87 ± 1.61 | – 2.26 ± 2.54 | |
| *IMPA* | BJA | 94.16 ± 6.38 | 0.917 | 97.96 ± 4.71 | 3.44 ± 5.82 | 0.713 |
| | AA | 94.58 ± 11.36 | | 98.65 ± 7.92 | 4.07 ± 6.53 | |
| *L1_FH* | BJA | 59.90 ± 7.56 | 0.718 | 55.64 ± 6.07 | – 4.26 ± 5.88 | 0.321 |
| | AA | 61.44 ± 11.49 | | 58.25 ± 6.15 | – 3.18 ± 7.65 | |
| *MP_FH* | BJA | 25.66 ± 4.26 | 0.179 | 27.06 ± 4.55 | 1.40 ± 2.06 | 0.079 |
| | AA | 23.30 ± 3.7 | | 22.89 ± 5.11 | 0.41 ± 3.81 | |
| *U1_SN* | BJA | 106.20 ± 10.15 | 0.472 | 101.23 ± 9.06 | – 4.97 ± 5.23 | 0.171 |
| | AA | 109.11 ± 8.85 | | 105.81 ± 5.17 | – 3.30 ± 6.50 | |
| *U1_L1* | BJA | 123.73 ± 11.98 | 0.855 | 124.45 ± 13.47 | 3.48 ± 12.23 | 0.587 |
| | AA | 123.52 ± 9.11 | | 122.8 ± 9.16 | 0.09 ± 7.27 | |

The dento-skeletal effects of BJA patients were compared to those of a group treated with AA. No statistically significant differences were found between BJA and AA groups at T0 and T1 (Table III). Both appliances were effective in correcting overjet and molar relationship.

AA determined a greater retraction of the upper incisors (AA Δ is/OLp - A/OLp: -1.75±3.18 mm vs BJA Δ is/OLp - A/OLp: 0.10±2.62 mm) and a slight advancement of the lower incisors (AA Δ ii/OLp – Pg/OLp: -0.22±2.69 mm vs BJA Δ ii/OLp – Pg/OLp: 0.16±1.77 mm). The dental correction of overjet in BJA and AA groups was 47.4% and 6.1% respectively. In BJA group, the maxillary molars moved distally 1.30±2.79 mm, while they tended to move mesially (0.98±2.92 mm) in AA group. AA determined a greater mesialization of the first lower molars (AA Δ mi/OLp – Pg/OLp: 1.91±8.47 mm vs BJA Δ mi/OLp - Pg/OLp: 0.57±3.21 mm). The dental correction of molar relationship was 37.8% in BJA group and 20.1% in AA group. Sagittal mandibular length increased slightly more in BJA group (BJA Δ Pg/OLp+Co/OLp: 8.92±8.67 mm vs AA Δ Pg/OLp+Co/OLp: 7.25±4.47 mm), whereas AA determined a slightly greater increase in total mandibular length (BJA Δ Co-Gn: 9.21±8.57 mm vs AA Δ Co-Gn: 10.06±5.35 mm). SNA increased slightly in BJA group (0.77±1.11°), whereas it decreased in AA one (-1.49±3.43°). BJA determined a greater increase in SNB than AA (BJA Δ SNB: 2.52±2.41° vs AA Δ SNB: 0.82±2.69°).

## DISCUSSION

Functional orthopedic treatment is effective in correcting Class II malocclusion in children aged 8-10 years (14-15). According to Martina et al. (5), BJA produced a significant increase in mandibular growth, improving overjet and molar relationship. Nucera et al. reported that functional orthopedic appliances produced a slight narrowing of the maxilla without a significant change of its inclination (16). On the contrary, we noticed that neither BJA nor AA inhibited the sagittal and transverse maxillary growth during the observational period. According to Illing et al. (11) SNA did not change significantly between T0 and T1 (P=0.056).

The relationship between the significant increase in maxillary length and the slight increase in SNA angle was explained by the fact that BJA determined the growth of the maxilla by rotating it backward. In fact, U1_SN decreased from T0 to T1 (Δ U1_SN: -4.97±5.23°; P=0.015). Since no dental variations were observed, we can state that the maxillary growth direction was slightly directed downward and backward.

Regarding the mandible, there was a significant increase in the mandibular base position after BJA and AA treatments (BJA Δ Pg/OLp: 7.40±3.81 mm, P<0.001 vs AA Δ Pg/OLp: 7.82±9.95 mm, P<0.001). The total mandibular length increase (Δ Co-Gn: 9.21±8.57 mm; P=0.008) was very similar to that recorded by Giuntini et al. (17) in subjects treated with Twin-Block (TB) during the growth peak (9.4±3.1 mm; P<0.001). We noticed similar Co-Gn increase between BJA (9.21±8.57 mm) and AA groups (10.06±5.35 mm): these increments were greater than those reported by Tulloch et al. (3.69±1.47 mm; P<0.001) (18). Sagittal mandibular length (Pg/OLp+Co/OLp) showed a mean increase of 8.92±8.67 mm (P<0.001).

We can state that BJA significantly influenced the mandibular growth more than TB (5.30±3.60 mm) in the study of Baysal et Uysal (19). This is attributable to the BJA prongs which maintain the mandibular protrusion both day and night (20-26). In fact, it is important that the patients wear the appliance especially during the sleep because there is an increased bone turnover overnight (27-33). Although less marked than in Martina et al. (5), the increase in basal bone was significant as it represented 93.9% of the molar relationship correction. ANB decreased of -1.66±1.33° (P=0.003).

According to Schaefer (34) and Baysal (19), the functional orthopedic treatment with removable appliances leads to a significantly greater increase in the anterior repositioning of the mandible than using fixed appliances. Condylar head position did not change (-0.05±2.82 mm, P=0.956) during treatment with BJA: the mandible was not anteropositioned and the correction of Class II malocclusion occurred mainly thanks to an increase in mandibular length. Therefore, molar relationship correction was more skeletal than dental.

Vertical skeletal variables did not change significantly in BJA group. This was probably related

to the prongs of BJA, which prevented the clockwise rotation of the jaws (5). The overjet reduction was 4.27±2.05 mm (P<0.001) in BJA group: this result was superimposable to the correction occurred in AA group (4.95±1.96 mm; P<0.001). The dental correction of overjet (given by the retroclination of the upper incisors and the proclination of the lower incisors) represented only 6.1% of the total correction, indicating a significant skeletal growth of the mandible. The slight increase of is/OLp-A/OLp (0.10±2.62 mm) and ii/OLp-Pg/OLp (0.16±1.77 mm) indicated that displacement of the maxillary and mandibular incisors was not significant (P=0.621 and P=0.364). Molar relationship correction was significant between T0 and T1 (4.95±1.96 mm, P<0.001). The distalization of the maxillary first molar was moderate (1.30±2.79 mm; P=0.164) and the mesialization of the mandibular first molar was mild (0.57±3.21; P=0.787): this indicated that the dental molar relationship correction was 37.8%, whereas the skeletal one was 62.2% in BJA group. Therefore, Class I occlusion was obtained thanks to an effective increase in mandibular length. IMPA was 3.44±5.82° (P=0.094). Several Authors (35-50) reported statistically significant differences regarding the proclination of the lower incisors by comparing the group with removable functional orthopedic appliances to a control group. In our study we did not find this significant proclination; this could be due to the acrylic coverage of the lower anterior teeth (5).

BJA treatment determined a Class I occlusion in all patients. The correction of molar relationship was mainly due to the increase in mandibular length rather than to the distalization of the maxillary first molars and the mesialization of the mandibular ones; the correction of the overjet was due to the increase in mandibular length, to the slight proclination of the lower incisors and the mild retroinclination of the upper incisors. BJA did not determine a significant clockwise rotation of the jaws with effects on the divergence. No significant differences were found in effectiveness between BJA and AA.

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# Platelet rich plasma grafting technique combined with trans-sinusal post-extractive implants placement in the posterior maxilla: a technical report and brief literature review

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**The atrophic posterior ridges are usually characterized by poor bone quality and quantity: this situation requires the use of bone regenerative techniques. Other alternative surgical approaches are investigated. Nowadays the use of trans-sinus implants offers some advantages due to its feasibility. Today, bone grafting may be practical, but depends on many factors, such as the type of bone graft used (autogenous, alloplastic, or xenograft), host response, age of the patient, various complications associated with grafting procedures, infection, and, most importantly, the time spent while the grafted material matures and is taken up by the bone. So, this case report describes the feasibility of an alternative surgical technique associated to PRP (Platelet Rich Plasma).**

The atrophic posterior ridges are usually characterized by poor bone quality and quantity: this situation requires the use of bone regenerative techniques which range from very simple ones to more complex and investigative as osteo distraction (1) or free vascularized fibula flap (2). Other alternative surgical approaches are investigated such as PRP (Platelet Rich Plasma) combined with implants. Nowadays the use of tilted implants offers some advantages due to its feasibility. Today, bone grafting may be practical, but depends on many factors, such as the type of bone graft used (autogenous, alloplastic, or xenograft) (3), quality and quantity of keratinized tissue (4-6), host response, age of the patient, various complications associated with grafting procedures, infection (7-9), unusual clinical anatomy (10), rare condition (11-20) or and, most importantly, the time spent while the grafted material matures and is taken up by the bone. On the other hand all it needs for using PRP is a blood sample from the person who is undergoing the surgery; that means a higher and better compliance by patients, less procedures, less morbidity, shorter rehabilitation times and costs. Usually, an atrophic posterior area is characterized by poor bone quality and quantity: this situation requires the use of bone regenerative techniques using or not computer-support (21), such as sinus lifts or short implant insertion (22-23), or bone regeneration with vertical/horizontal crestal onlay grafts. (24-25) Today, bone grafting may be practical, but depends on many factors, such as the type of bone graft used (autogenous, alloplastic, or xenograft) (3), feature of keratinized tissue (4,6,26), inter arch space (27), host response, age of the patient, various complications associated with grafting procedures, infection (7), and, most importantly, the time spent while the grafted

*Key words: platelet rich plasma, atrophic posterior ridges, bone regenerative techniques, surgical approaches*

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**DISCLOSURE: ALL AUTHORS REPORT NO CONFLICTS OF INTEREST RELEVANT TO THIS ARTICLE.**

material matures and is taken up by the bone. One review revealed that there are few studies providing data on the success rates of dental implants placed in onlay graft augmented ridges and demonstrated, on average, poor methodological quality (28).

A reasonable method to bypass few issues previously mentioned is the PRP (Platelet Rich Plasma) that is an autologous high concentrate of human platelets enclosed in a small volume of plasma (approximately 60% of the same amount of blood) thanks to the elimination of water, buffy coat made by leukocytes, erythrocytes and other low molecular weight substances (29). Within it, various growth factors are kept active (PDGFs, TGFbs, VEGF, EGF) as well as cellular adhesion proteins (fibrin, fibronectin and vitronectin) with osteoconductive activity (30). PRP consequently has the capacity to implement the normal processes of cell differentiation and replication, to stimulate neo angiogenesis, to product a greater quantity of collagen and therefore a greater neoformation of mature bone tissue and a better healing of wounds (31).

Moreover, the placement of an angulated implant, which avoids both invasive procedures (like a sinus lift) and bone augmentation procedures (32), may be a viable treatment option (33). However, some alternative techniques can also be used, such as implant placement in front of the sinus, or in the intra sinus septa, or palatal to the sinus. Thus, the same amount of bone may allow the insertion of two implants: one axial and another tilted to support a three-element prosthetic fixed unit without a cantilever (34-35). Here, we describe a case report of a maxillary immediate fixed rehabilitation, with axial and tilted transinusal implants supported in the fresh-post extractive sockets combined with PRP technique.

## MATERIAL AND METHODS

An 84-year-old woman was referred to our private clinic (Centro Medico Vesalio, V. Sorio, Padova, Italy) for rehabilitation of her upper left maxilla. Her medical history revealed only one previous episode of ischemia. Clinical observation revealed some caries-destroyed teeth and missing teeth in the upper left maxilla (Fig. 1-3).

Given this clinical situation, a minimally invasive implant surgery was suggested to the patient to avoid bone regenerative techniques, such as a sinus lift (Fig. 4) Thus, tilted implant placement was planned to support an immediate fixed three-unit element prosthesis to restore her upper maxilla. Her treatment goals were to re-establish lost function and esthetics with a fixed prosthesis to minimize the period without teeth and to avoid removable prosthesis. The patient was carefully informed about the possible treatment options: sinus floor elevation with delayed implant placement and prosthetic restoration, or an immediate fixed prosthesis supported by one axial implant and one tilted posterior implant. The patient chose the second option and signed an informed consent form.

After local anesthesia had been administered, a mucoperiosteal flap was raised, exposing the facial bone of the left maxilla. After teeth extraction, starting from the area of the first molar, the implant site was prepared

**Fig. 1**. *Frontal aspect of the caries destroyed teeth.*

**Fig. 2**. *Lateral and occlusal aspect of the caries destroyed teeth.*

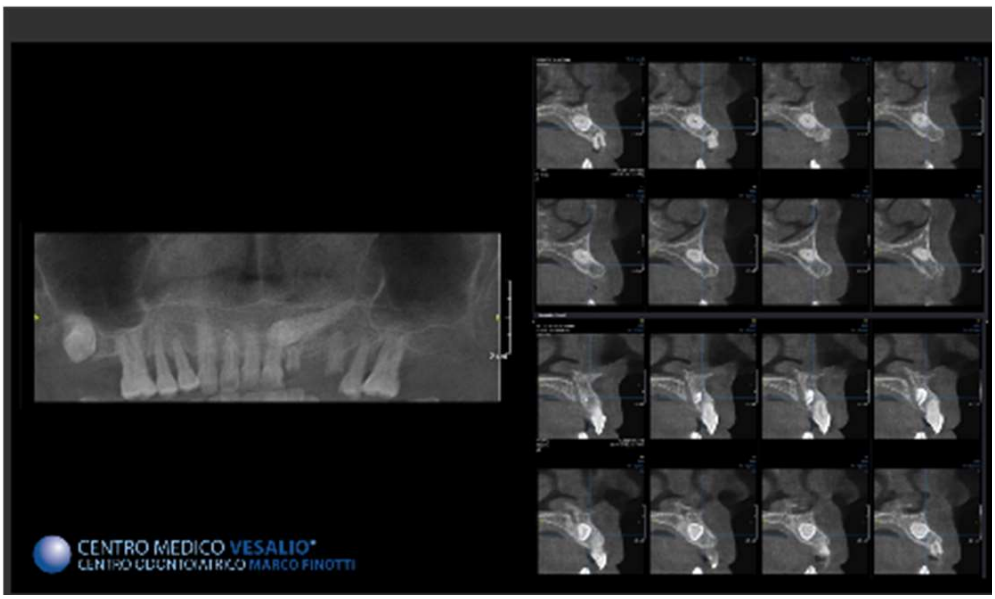


**Fig. 3**. *First screen shot of the previous CBCT exam.*


**Fig. 4**. *Radiological check before implant placement: the multi corticalism of the drill can be appreciated.*

with a 30° mesial inclination passing in front of the sinus cavity and proceeding in the apical portion of the bone, anterior to the sinus (Fig. 5). A tilted implant was inserted (Win6 BioSaFin, Milan, Italy; 15 mm long and 3.8 mm in diameter). Another couple of Win6 BioSaFin fixture (15 mm long and 4.5 mm in diameter) was inserted axially in the socket of the canine and first premolar. Both implants reached a final insertion torque higher than 40 Ncm (Fig. 6).

Then, two 30° multi-unit abutments (MUA) were connected over the posterior and anterior implants (Fig. 7-9). All the grafted Bio-Oss (Geistlich Biomaterial), used to fill up the bone sockets, was subsequently covered by a reinforced membrane and the above mentioned PRP graft (PRGF-Endoret Dental technique following the BTI System Protocol).

After the surgery, a three-unit composite resin interim prosthesis was relined with Combo Lign Bredent (Bz, Italy) and connected to two temporary abutments. Slight contacts in maximum intercuspation were registered and any lateral excursions were removed (Fig. 10-12).

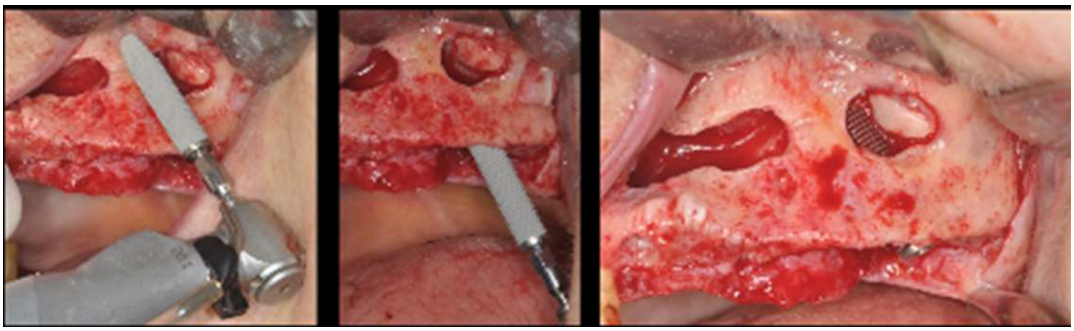

**Fig. 5**. *Surgical orientation of the transinusal tilted implant.*

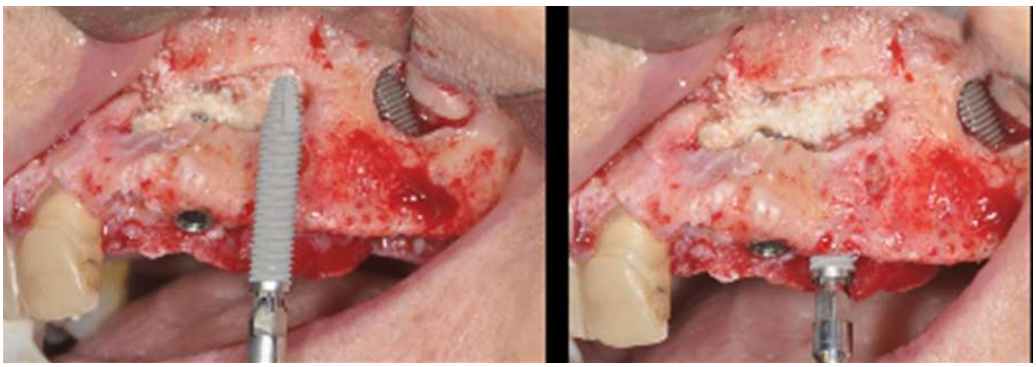

**Fig. 6**. *The final phase of implants placement.*

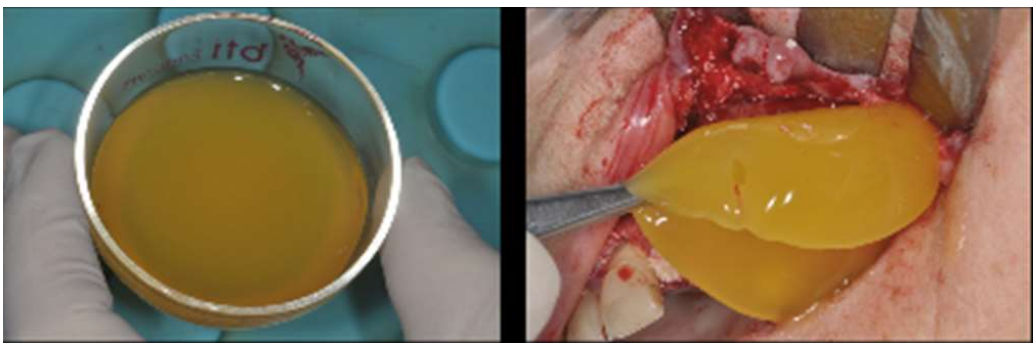

**Fig. 6**. *The final phase of implants placement.*

## RESULTS

Here, we present a technique for the immediate fixed restoration of the posterior maxilla in an elderly patient requiring surgical treatment of reduced duration. Mattsson first reported the concept of tilted implants in oral surgery to support a full-arch fixed prosthesis in patients affected by severe maxillary atrophy (36). In 2001, Aparicio applied this concept to rehabilitation, through a fixed implant-supported prosthesis of the posterior maxilla as an alternative to a sinus lift (37). In total, 25 patients received 101 implants: 59 axial implants and 42 tilted implants. After 5 years of follow-up, the success rate was 95.2% for tilted implants and 91.3% for orthogonal implants. The marginal bone loss was, on average, 1.21 mm for the tilted implants and 0.92 mm for the axial implants. Thus, it was concluded that this surgical approach was a valid and practical alternative to a sinus lift in the rehabilitation of the atrophic maxilla.

Moreover, in 2005 Calandriello conducted a study of 18 patients, treated with 60 implants supporting fixed partial/total prostheses, and reported a 96.7% success rate (mixed) and bone resorption values of 0.82 mm for axial implants and 0.34 mm for tilted implants (38). No significant difference was found between axial and tilted implants regarding the

**Fig. 7**. *The PRP graft placement.*

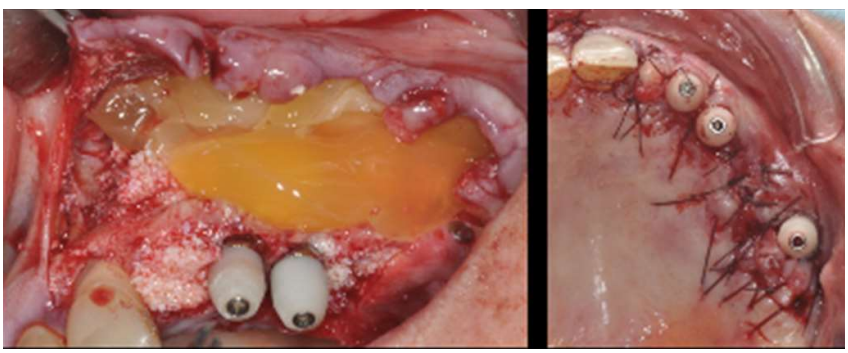

**Fig. 8**. *Lateral aspect after PRP grafting.*

**Fig. 9**. *Frontal and occlusal aspect of the interim screws retained prosthesis.*

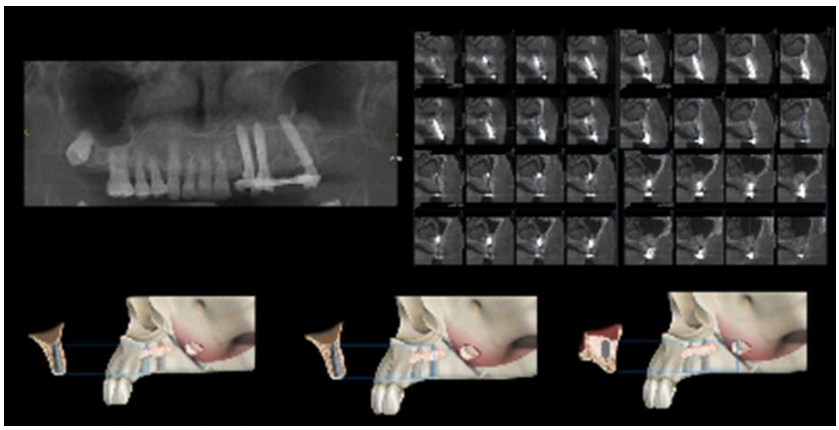

**Fig. 10**. *Graphic representation of the planned treatment.*

**Fig. 11.** *Frontal aspect of final screws retained prosthetic restoration and the image of angled MUA.*

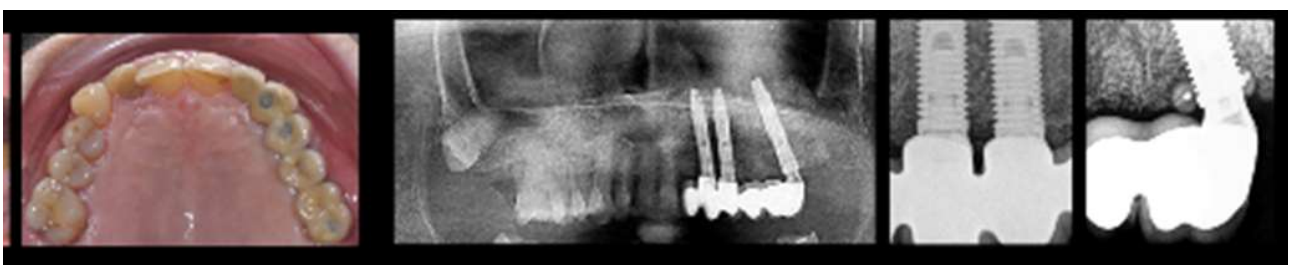

**Fig. 12.** *Occlusal and radiological aspect of the final screws retained prosthetic restoration.*

implant-related prevalence of peri-implant mucositis, peri-implantitis, or implant loss (39). Lekholm reported that a 14 mm distance between the canine bone and the distal implant allowed fir rehabilitation of an atrophic maxilla with one axial and one tilted implant without a prosthetic cantilever (40).

The use of longer implants increases the bone-implant contact (BIC) in a low-quality bone region; moreover, it allows the cortical bone to be reached with increased primary stability (41) and, consequently, it is possible to install an immediate-load fixed implant-supported prosthesis. In our case, we decided to use a tilted distal implant in the mesial-palatal direction to take advantage of the native bone. Thus, we used two 15-mm long fixtures to reach more cortical bone.

The tilted implant impacted against the mesial sinus cortical margin with its distal surface, such that 'bicorticalism' was achieved, thereby improving primary stability and permitting an immediate load (42). The only risk in this procedure depends on the flexibility of the bone, which could be subjected to

excessive stress due to the prosthetic components (43-47). The use of an immediate loaded full-arch prosthesis, supported by two mesial axial implants and two distal tilted implants, is a viable rehabilitation option, considering the lower rate of peri-implant mucositis and peri-implantitis compared with that reported in the literature (39).

Since their first use by Marx in 1998 PRP have been utilized in pre-prosthetic oral surgery for atrophic maxillae rehabilitation using axial and/or tilted implants in association with autologous bone grafting or alloplastic biomaterial (such as coral hydroxyapatite) (29, 48) and with sinus lift elevation (29, 49-50). The greatest advantages of using PRP with coral hydroxyapatite are that the new bone formation processes are equivalent to those obtained with autologous bone grafting (golden standard) (29, 51).

A systematic review of literature has been published recently focused on RCT and CCT studies using PRP in all fields connected to implant dentistry including sinus floor augmentation, socket preservation, ridge augmentation or peri-implantitis. The aim was to evaluate the current knowledge with respect to the clinical indications of PRP on soft tissue healing and bone regeneration with respect to implant placement (52). PRP was found to provide a higher bone width, higher bone density, and less marginal bone resorption at 9 and 12 months (53). With all the information listed above, the idea was born to experiment the utility of PRP in the insertion of axial and tilted transinusal implants. This technique offers several advantages:

- Stability even with minimum bone volume: longer implants can be used with minimum bone volume to increase BIC and reduce the requirement for vertical bone regeneration.
- Cortical anchorage may be achieved through longer fixtures (18, 20, 25-mm long).
- Good clinical results.
- Stimulation of neo angiogenesis, secretion of collagen, neoformation of mature bone tissue (31).
- Better healing of wounds (31).
- Avoids invasive bone regenerative techniques.
- Can be performed in patients with various systemic conditions that are often contraindications for bone grafting.
- Angulations allow implant placements that avoid anatomical structures.
- There is a biomechanical advantage to using tilted distal implants rather than distal cantilever units (54).
- Reduction of the length of cantilevers without performing bone grafting or sinus lifting (55).
- Effective and safe alternative to maxillary sinus floor augmentation procedures and to a pneumatized maxillary sinus (33).
- Distally tilted implants induced better loading transmission than vertical implants (56).
- Excellent prognosis in the short-to-medium term as well as over the long term (57).
- Higher and better compliance by patients.
- Less procedures, less morbidity.
- Shorter rehabilitation times and costs.

However, the technique also has some disadvantages. First, it assumes that the surgeon has biomechanical knowledge and experience in the management of prosthetic immediate loading and is a higher sensitivity surgery. There are several other considerations that should be kept in mind when using this approach: the use of angulated implants should remain confined to situations of favorable bone quality (preferably greater than D3) and angulated implants should only be placed after suitable three-dimensional planning.

Greater inclinations of the implants (>30°) lead to increased force at the implant-bone and implant-abutment interfaces. Thus, extreme angulation should be avoided. We suggest an inclination between 15° and 30° (10). Cavallaro and Greenstein, after evaluating the proportion of survival and complications (biological and technical) associated with tilted abutment-supported prostheses showed that increased abutment inclination creates a greater amount of tension on the prosthesis and the surrounding bone. However, the increased tension was not associated with any significant reduction in the longevity of the prosthesis. Moreover, it was not associated with any increase in the incidence of fixation screw loosening (58).

A trigonometric ratio was developed to estimate the two-dimensional safe distance between a tilted implant and an adjacent vertical implant. The distance

or length between the fixtures can be determined by multiplying the known length of each implant by a constant derived from the sine of the insertion angle. In edentulous maxillae, if the inter-implant distance is increased, the load distribution will be better (59-69).

Moreover, we used an internal hexagonal connection, which offers better force dissipation. The cortical preparation is also reduced due to abutment placement: this helps with the primary stability. In addition, the internal hexagonal connection may be more coronal, which could lead to a reduction in the micro leakage of bacteria (3, 12, 14-15, 70-71). Prosthetically, the internal hexagonal connection has some procedural disadvantages, but it offers a better implant abutment seal, fewer prosthetic complications due to lower pin fixation stress and, finally, the possibility of a better prosthetic finalization of the abutment (16-20, 72-75). Last but not least we should underline that the production of PRP must be carried out by specialized and approved laboratories (76); and also it could be considered expensive using in private practice (quick estimates on web account for spending between 300 and 600 USD).

## DISCUSSION

The surgical approach described here is sensitive and useful in patients with atrophic ridges. Long-term studies are required to evaluate its success rate in terms of load distribution, marginal bone loss around the implant, and prosthesis survival, although currently many practitioners are treating patients with this technique. Generally, we can state that rehabilitation using tilted implants combined with PRP offers many advantages versus the use of bone grafts (onlays, sinus lift) and short implants. This type of surgery is faster, safer, more predictable, less expensive and invasive, and allows the application of an immediate load protocol when primary stability is achieved. This case report shows the feasibility of the technique in achieving clinical success, as well as surgeon and patient satisfaction.

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# Interceptive use of pendulum for advance resolution of class II patient: a guided eruption plan to reduce stress on permanent teeth root

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**Use of the so-called distalizing mechanics is a common treatment to correct class II malocclusion. One of the first appliances made for molar distalization was the pendulum, which resulted immediately efficient. The knowledge of pendulum efficacy, in regards to distalizing treatment in adolescence, has guided the research to analyze pendulum effect in childhood: checking the pre-eruptive, natural and distal movement of upper second premolar following first upper molar distalization in order to obtain an advance resolution on Angle's Class II patient, limited treatment time, reduced periodontal inflammation and stress on permanent teeth root. A pilot study testing the possibility of a prospective study was necessary on 6 patients treated following an accurate protocol (6 months and 1-year Rx control) and 6 patient control after one year. Statistical analysis by T-Test was done. Oral hygiene controls every month were done. Second upper bicuspid vertical (1.6mm) and sagittal (2.5mm) movement mean values allow to emphasize a distal variation of tooth axis inclination of treatment group than control group, and a second upper bicuspid distal departure from "*gubernaculus dentis*" of second deciduous molar in treated patients. Periodontal inflammation appears inexistent on second and first upper premolar germs after the comparison between RX exam of treatment and control groups because of exploiting deciduous teeth. Besides periodontal inflammation and teeth root stress on first upper molar of treatment group, after RX analysis, results were limited compared to control groups because of the advanced orthodontic interceptive treatment during a previous stage of first upper molar root development.**

Progress of knowledge in each field of dentistry (1-5) is the main aim of every research, starting from an idea: distalization of the first upper molar is a fundamental procedure that we can count among the main objectives of an orthodontic treatment. The use of so-called distalization mechanics is a common treatment method to correct Class II malocclusions. This type of orthodontic mechano-therapy is typically used in patients with dentoalveolar maxillary prognathism or any compensation, associated with extractions, in patients with skeletal maxillary prognathism. However, the distalization of the upper first molar, through extra-oral tractions, has always needed the cooperation of the patient, which is the most significant problem reported by all orthodontics specialists (6). Traditional approaches of molar distalization, including extraoral traction, Wilson's distal arch, removable devices with distalizing springs and intermaxillary elastic bands require a significant patient "compliance" to be successful in

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therapy (7). While more recent therapies with the help of miniscrews, for example Loca-system (8), associated with the anchoring of the second premolar, are often "seen" as too invasive and therefore hardly accepted by patients' parents (7-9).

Since the late 1970s, various intra-maxillary anchor devices for distalization of the upper molars have been introduced as an alternative to extra-oral traction. The main and fundamental advantage of these innovative non-removable devices is that they are independent of the patient's compliance (7-10). Clinical studies (11-13) have shown that in principle all fixed intra-oral distalization devices are capable of successfully achieving molar distalization in the upper jaw. However, success must not be evaluated exclusively according to the clinical criterion of space gained between the first permanent molar and the second permanent premolar/second deciduous molar, but also for the force applied to the first molars with the device and the reaction force given by the anchoring of the equipment itself (7-9). The loss of anchorage in the distalization leads to mesialization with inclination on the anterior anchorage teeth. Furthermore, depending on the dentition phase, the anchorage will develop on the permanent premolars or deciduous molars (7-9). One of the first methodologies created of molar distalization to be efficient and therefore to spread easily was the pendulum, created by Hilgers (14-15) in 1992 precisely in order to avoid the need for collaboration of the patient (16). An evaluation of the excellent dentoalveolar and skeletal effects of the pendulum in class II patients has been reported by Bussick and Mc Namara (17). Having observed the excellent results with the equipment, over the years we have proceeded to modify its characteristics to increase its effectiveness. The evolution therefore provided for the introduction of a median expansion screw, inside the Nance button, in order to limit the medial displacement of the first upper molars determined by the distalizing springs, thus being able to perform the distalization simultaneously with a necessary expansion skeletal maxilla through the introduction of Pendex (18).

As the effectiveness of the device was confirmed, a single-sided variant was then developed for the distalization of a single molar using the single-sided Pendulum (19). In an attempt to improve the effectiveness of the distalizing springs, we proceeded to use "K-loop" with the pendulum K obtaining a more efficient distalization with the reduction of the distal inclination of the first molar and less bone loss in the anterior group (20). Finally, the advent of the mini-screws made it possible to relate the skeletal anchorage to the conventional anchorage thus involving the construction of variants of the pendulum with anchorage generally guaranteed by two mini-screws positioned palatally at the level of the third "palatine wrinkle" stabilized in the Nance button.

The anchorage was similar or superior to the conventional anchorage allowing a higher treatment speed (21, 22). The continuous evolution of the equipment in question and the experience accumulated in distalization and lingual therapy at the University of Padua by the working group led by Prof. L. Favero has also led to its use associated with contemporary alignment lingual therapy of the anterior superior incisal group with Pendulum F which can be used in the calculation of a treatment of the patient's total upper arch (7). It appears evident that the pendulum can therefore be considered the distalizing equipment of choice, given its continuous evolution and efficacy in clinical practice compared to other equipment (23- 28).

Following the clinical evolution and the bibliographic evidence described above, however, wanting to follow this mode of therapy, we must pay attention to the quality of anchoring (following the traditional method and leaving out the skeletal anchorage), which is mainly based on the characteristics of the periodontal tissues. The resistance potential of the anchoring teeth is determined by the size of the dental elements used, the number of teeth, the reabsorption phase of the roots of the deciduous elements (attachment level, bone structure, periodontal response).

In fact, in children and adolescents treated with molar distalization devices, the bone structure and the attachment level can be considered practically identical. The differences in anchoring can result from the number of teeth, the root structure, and

periodontal reactivity. Although the results are not entirely consistent in the literature, the side effects in relation to the anchor occurred more often in clinical studies in which only two deciduous dental elements were part of the anchor. Therefore, the largest number of deciduous elements should be included in the anchor (29).

Furthermore, some clinical studies have examined the effectiveness of molar distalization devices in mixed dentition (29, 30). In terms of anchoring, they have found that deciduous molars, as well as permanent premolars, are in principle suitable for making the anchor for molar distalization with the pendulum but anchoring exclusively for deciduous molars or mixed between deciduous molars and Permanent premolars reduces the quality of the anchor (30, 31). Conventional anchoring methods deserve critical discussion. On the one hand, the anchoring effect of the palatal acrylic structure is uncertain, while the limited oral hygiene given by the temporary partial coverage of the palate is a recognized problem.

Furthermore, mesial migration of the anterior incisor group must be considered, as the results of all studies in the literature show. Finally, some dento-periodontal phases do not allow the construction of a sufficient anchor (29) but suggest that distalization in the interceptive phase could be indicated so as to avoid side effects in anchoring on the permanent dentition (32, 33) knowing that the maximum maxillary distalization of the first molar, with minimal increase in facial height, anterior is obtained by performing distalization with the pendulum in mixed dentition before the eruption of the upper second premolars (16). In conclusion it must be considered that the use of distalizers, including the pendulum, with the achievement of a good anchorage in permanent dentition involves a physiological natural movement following the distalization of the first molar by the second premolar through the traction of the transeptal fibers now certified in literature (34, 35, 36). While the pre-eruptive movement of the germ of the second premolar due to the superior traction force of the transeptal fibers in formation of the root body of the same, with respect to the anchorage given by the gubernaculum dentis (37, 38) of the second deciduous molar has not yet been evaluated, despite having multiple studies on the effects of distalisers in mixed dentition. Beside the effects of an advance resolution on Angle's Class II patient: previous treatment time, reduced periodontal inflammation and stress on permanent teeth root have not been evaluated. The aim of the current study is to complete the extensive research carried out. The purpose of this work will be to analyze the use of the pendulum in the interceptive phase, then in mixed dentition, in order to obtain the best distalization of the first molar and to specifically evaluate the effects on the second premolar during therapy. Advanced resolution on Angle's Class II patient by distal eruption of these elements, would reduce the possibility of molar recurrence by increasing the effects of treatment with the pendulum anchored on the deciduous molars and the possibility of limited treatment time, the reduction of periodontal inflammation and stress on permanent teeth roots.

## MATERIALS AND METHODS

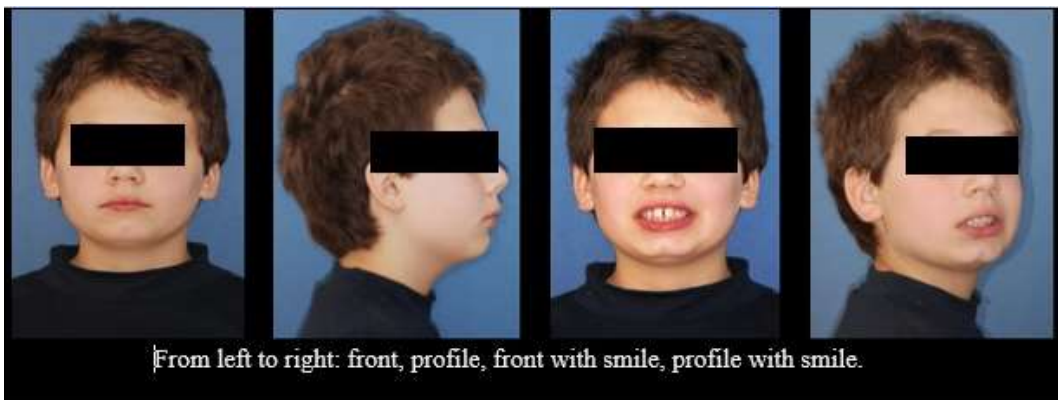
Prospective study protocol (38, 39, 40, 41, 42, 43):

- patients (homogeneous group) being treated at the University of Padua and in control at the University of Florence (in collaboration with Ann Arbor University, Michigan USA);
- angle's Class II dental and/or skeletal;
- age between 8-8.5 (early mixed dentition, stage 1) (43, 44, 45);
- first and second deciduous molars (deciduous canine);
- eciduous molars at the beginning of rhizolysis (43, 44);
- oth male and female (43);
- no previous orthodontic treatment;
- facial height in the norm, mandibular angle in the norm and normodivergent as skeletal parameters;
- oral hygiene controls every month;
- initial (T0), end of treatment (T1), one-year control (T2): orthopantomography associated with teleradiography in latero-lateral projection to measure the movement of the second premolar following superimpositions of pre-treatment and post-treatment cephalometries according to Bussick and Mc Namara (16) six months after treatment and one year later;

- six months of treatment in order to evaluate the interceptive effect using at the end the pendulum in passive restraint mode with the simultaneous section of the occlusal supports in sequence on the second and first molars in order to favor the distal displacement of the upper second premolars favored by traction transeptal fibers (method that does not allow recurrence with mesial drift of the first upper molar) (7, 37, 38);
- need for anchoring with class II elastics between the first deciduous upper molar and the first lower molar to obtain a maximum anchoring of the equipment avoiding the mesial inclination of the upper anterior group (7).

Preliminary pilot study: to test the possibility of carrying out a prospective study was therefore necessary. It was performed on six patients, at the University of Padua, following the methods of the prospective study protocol, in order to ascertain the veracity of the distal movement of the second upper premolar after the first distalization of the upper molar obtained with the pendulum and the real possibility of execution since the treatment is aimed at patients still in "childhood" age. The selected patient sample will be compared with a control group of five patients after one year from the start of the control trial at the University of Florence (in collaboration with Ann Arbor University in Michigan USA). In fact, the distalization of the first molar would hopefully be able to create, behind the second deciduous molar, a space favorable to the spontaneous distal movement of the second premolar in the alveolar bone in order to obtain a natural mesial eruption at the upper first molar without any or minimum mechanics of supplemental distalization.

Description of the device: it consists of an acrylic structure (variant of the acrylic Nance button) which partially covers half of the hard palate starting from the




A


B

**Fig. 1.** ***a)*** *Initial photographic documentation (example)* ***b)*** *Initial photographic documentation (example).*

retro-incisal region. It is connected to the dentition through occlusal steel supports that extend from the lateral portion of the acrylic, in which they are anchored, and are cemented to the occlusal surfaces of the deciduous molars. Then a wire directed posteriorly extends from the distal part of the palatal acrylic, where it is anchored, to form a helical ring near the midline which then extends laterally so that it can be inserted in the palatal lanes on the cemented band of the first molars superior. These teeth are to be displaced distally and medially by these springs with a force of about 230 grams. Elastic anchoring class II (1/4 3.5 ounces) between the first lower molar (solidified through multi-band treatment to the lower mixed dental arch) are necessary in order to obtain a maximum anchorage and to minimize the mesialization of the teeth of the anterior incisal group.

Selected sample: the six patients selected for treatment are two males and four females (control group: two males and three females). The average age is eight years and five months. The whole sample has the deciduous dentition of the lateral sectors complete, without early resorption, carious lesions in progress and with a good oral hygiene capacity. All patients underwent initial fingerprinting, photos of initial documentation and cephalometric assessment (T0) using a computer program according to the Bussick and Mc Namara method (11) *(Fig.1a,1b,2,3,4a)*. The main sagittal, vertical and dental data were then collected in a pre-treatment summary table with particular attention to highlighting the position of the first upper molar and the second upper premolar with respect to the Frankfurt plane vertically and sagitally with respect to perpendicular to the Frankfurt plane passing through a cephalometric point Pt (junction point of the canal of the large round hole with the posterior edge of the pterygo-mandibular suture) *(Tab.I, IV)*. Starting from the obtained plaster cast and cephalometry, six case studies were

**Table I.** *Treated patients T0.*

| | *1p* | *2p* | *3p* | *4p* | *5p* | *6p* |
|---|---|---|---|---|---|---|
| *SNA°* | 75.1 | 89.1 | 85.3 | 80.7 | 82.6 | 78.8 |
| *SNB°* | 70.2 | 79.5 | 77 | 75 | 80 | 75.2 |
| *SNPg°* | 71.8 | 81 | 78.2 | 77 | 81 | 76.1 |
| *ANB°* | 4.9 | 9.6 | 8.5 | 5.7 | 2.6 | 3.6 |
| *WITS mm* | 5.9 | 6.4 | 5.6 | 4.5 | 3.6 | 4.2 |
| *Co-A mm* | 74.1 | 68.2 | 73.2 | 65.8 | 82.4 | 71.3 |
| *Co-Gn mm* | 94.8 | 79.8 | 83.1 | 78.5 | 92.9 | 81.9 |
| ***6+ mm – Pt I- PFH*** | **14** | **14** | **10.2** | **12.7** | **13.6** | **7.2** |
| ***5+ mm – Pt I- PFH*** | **32.5** | **30.7** | **25.8** | **28.3** | **17.4** | **23.4** |
| *S-N^Mx°* | 9.2 | 10.8 | 7.7 | 13.1 | 7.4 | 6.6 |
| *S-N^Md °* | 32.6 | 26.5 | 27.3 | 38.3 | 21.9 | 37 |
| *SNA-Me mm* | 56.9 | 46.6 | 49.9 | 49.8 | 49.1 | 54 |
| *PFH/Mx°* | 3.4 | 7.9 | 2.1 | 2 | 6.1 | 4.4 |
| *PFH/Occ°* | 8.4 | 10.1 | 11.1 | 13.4 | 7.1 | 9.4 |
| *PFH/Md°* | 21.7 | 19.3 | 22.4 | 23.1 | 16.2 | 22.7 |
| *Mx^Md°* | 24.8 | 20.2 | 19.8 | 31.7 | 20.9 | 31 |
| ***6+ mm - PFH*** | **32.7** | **27.6** | **29.3** | **36.3** | **32.1** | **33.3** |
| ***5+ mm - PFH*** | **29.2** | **24.7** | **27.5** | **36** | **28.6** | **33** |
| *Poligono di Biork°* | 392.6 | 394.4 | 387.3 | 390.4 | 381.9 | 395.2 |
| *Afp/Afa %* | 56.8 | 57.8 | 60.8 | 53.6 | 66.1 | 54 |
| *Is^Mx°* | 108.2 | 117.3 | 110.7 | 117.4 | 119.5 | 107.1 |
| *Iinf^Md°* | 93.2 | 100.2 | 93.7 | 98.8 | 98.7 | 92.2 |
| *Ovj mm* | 6.6 | 6.6 | 7.9 | 9 | 5.1 | 2.2 |
| *Ovb mm* | 3.2 | 2.5 | 3.1 | 1.2 | 2.9 | 2.4 |

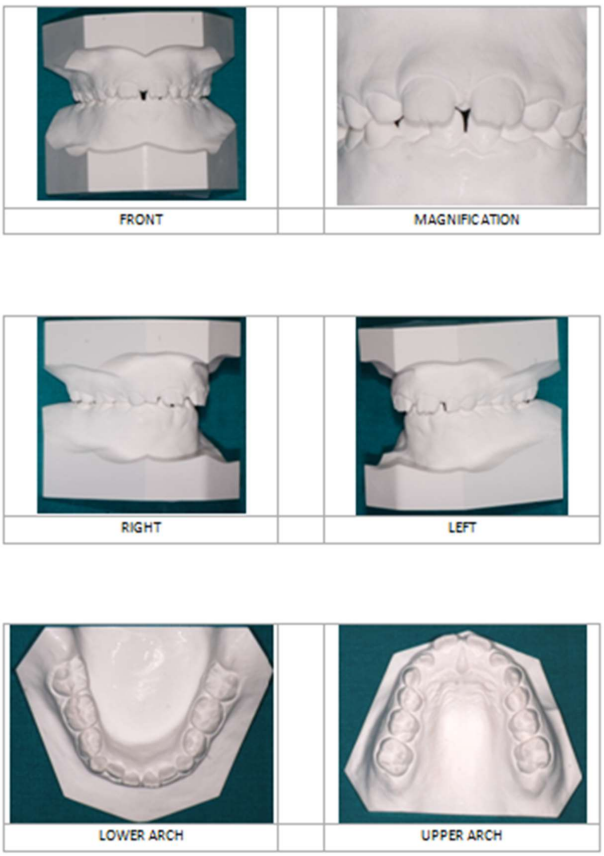



**Fig. 2.** *Gypso-documentation (example).*

obtained from which a diagnosis of second skeletal class, second molar class, slight lower anterior crowding, slight upper incisor exo-inclination in a general norm divergence picture (one of the patients females tended slightly to hyper-divergence in a however negligible way).

Clinical steps: once the informed consent to the treatment by the parents was signed, each patient underwent a bandage of the lower arch (information according to "Roth" in steel) with the use of an elastic thread 0.14 NITI HANT 12 for the first phase alignment of the lower incisors. In a second phase after about a month, given the slight degree of crowding of the lower anterior incisor sector, the desired alignment and leveling was obtained, thus being able to position a 0.16x0.22 NITI wire to the lower arch solidarizing the whole the lower deciduous teeth with a continuous metal ligature. In this way, the lower arch in mixed dentition was prepared to support the anchorage of the pendulum for the upper arch. At the same time, an impression was made and the test of the steel bands for the pendulum on the upper arch with occlusal supports on all the cuspid deciduous dentition *(Fig.4b)*.

The patients then, after a few weeks were subjected to the positioning of the pendulum in the upper arch cemented on the bands (glass ionomer cement) of the first upper

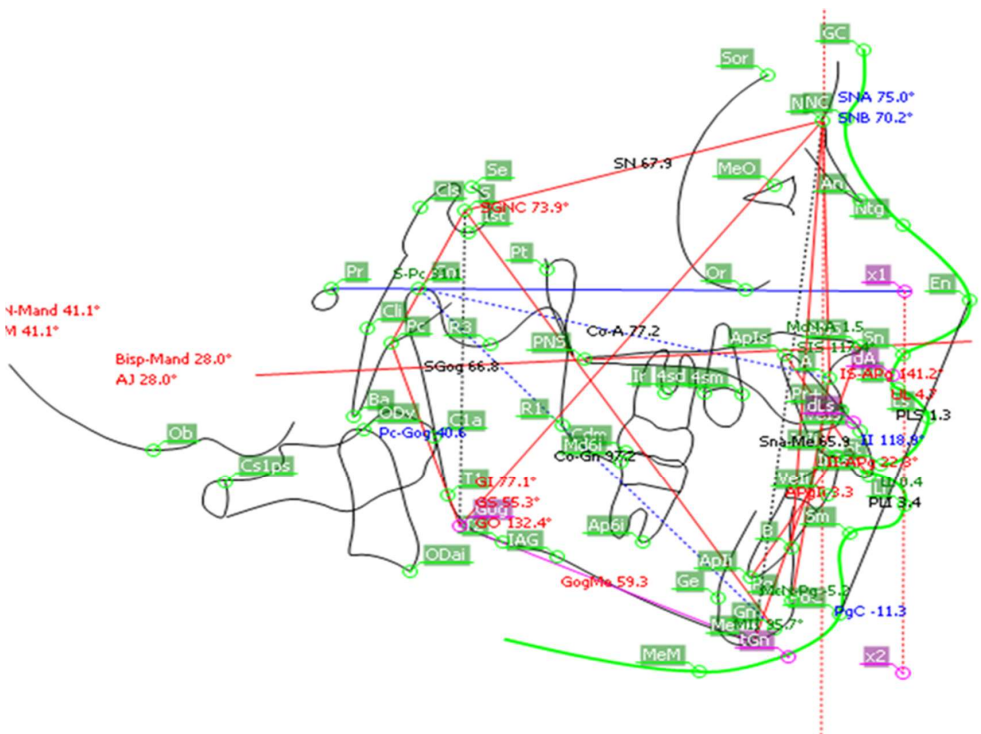
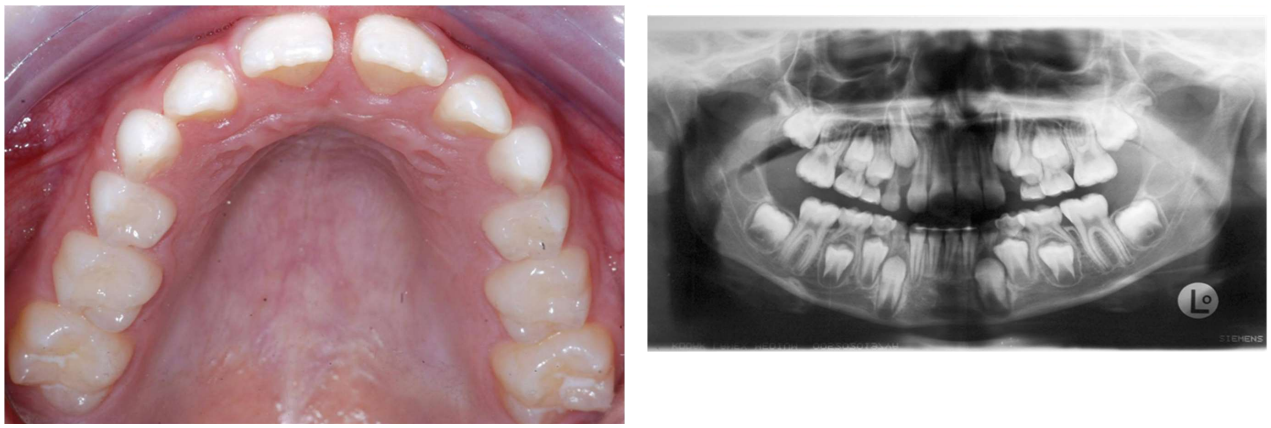
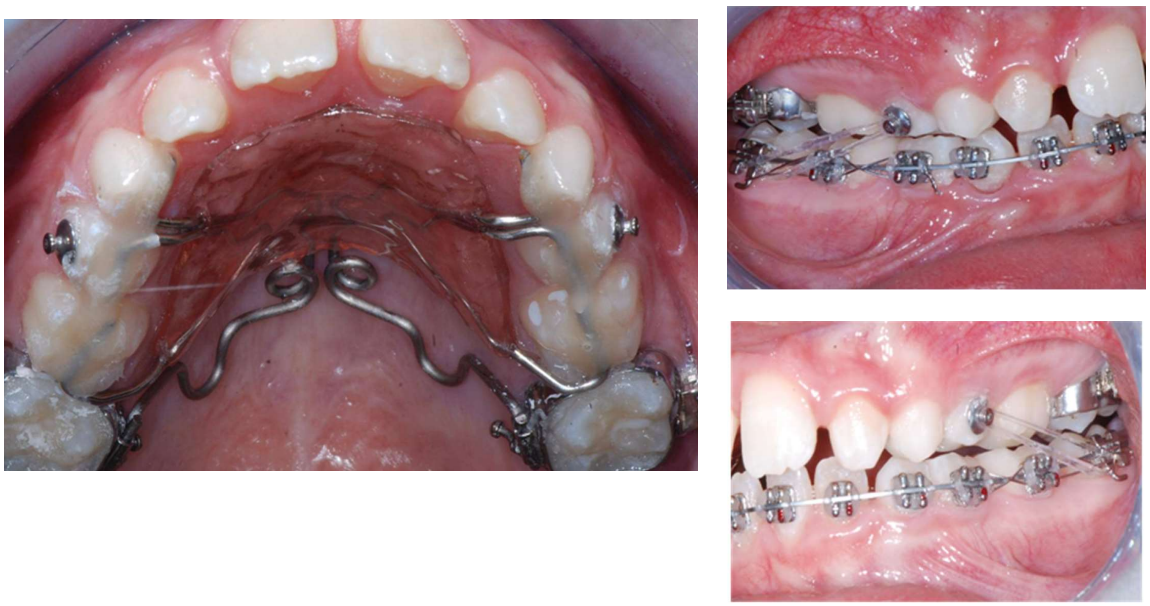


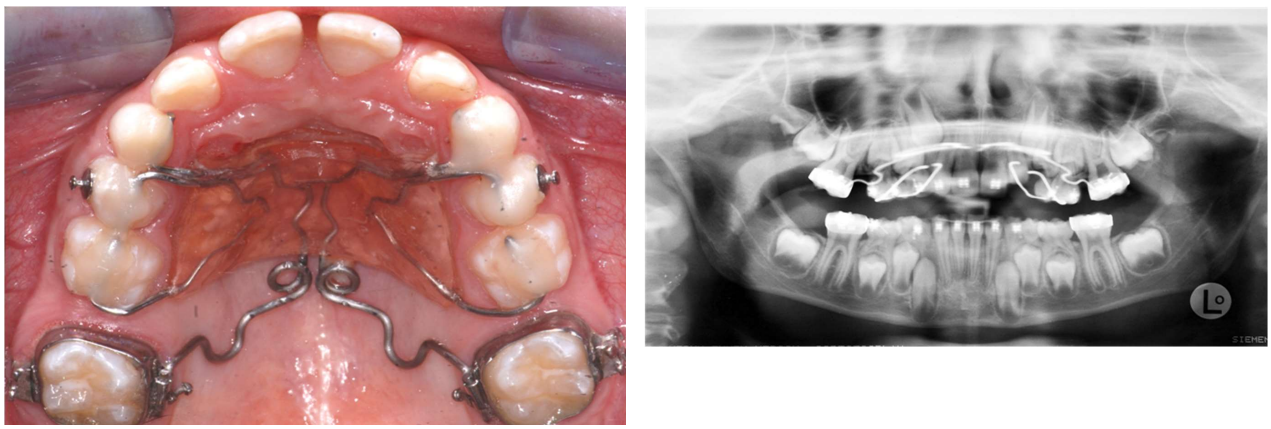

**Fig. 3.** *Cephalometric analysis before treatment T0 - treatment group (example).*



A



B



C

**Fig. 4.** ***a)*** *Photographic and radiographic documentation during treatment T0 (example)* ***b)*** *Photographic and radiographic documentation during treatment T1 (example)* ***c)*** *Photographic and radiographic documentation during treatment T2 (example).*

molars and anchored to the deciduous dentition through the occlusal supports through the use of fluid composite: after etching. During the positioning of the pendulum the rear springs were inactivated by a metal binding which is cut off once the application of the distaliser device is completed. Then the Pendulum is to be applied simultaneously to the bands limiting the discomfort in the patient and preventing any alterations of the distalising springs not having to subsequently insert them in the palatal support lanes of the bands. Finally, two vestibular buttons were positioned on the first deciduous upper molar for the attachment of the 2nd class elastics (diameter: 1/4, strength: 3.5 ounces) up to the first lower molar.

After a week, the tightness of the cementation of the equipment was checked and then, observing no loss of anchorage, the front portion of the acrylic structure was sectioned so as to prevent even the slightest vestibularization of the teeth of the anterior incisor group higher. All patients underwent orthodontic and photographic checks biweekly for the first month of therapy and then monthly for the following six months of distalization therapy, so as to be able to carefully monitor any detachments of the occlusal supports or buttons vestibular in order to avoid any loss of anchorage with consequent therapeutic failure. Being the sample of patients of "infantile" age, we also chose to perform a careful oral hygiene with each disassembly and reassembly of the lower arch.

At the end of the approximately six months of therapy, the occlusal supports of the first upper deciduous molar were sectioned to further favor the distal displacement of the second upper premolar causing the eruption distalized to the exfoliation of the deciduous. Disclosure of results: at the end of the first quarter, the displacement of the first upper molar in the position of the first molar class

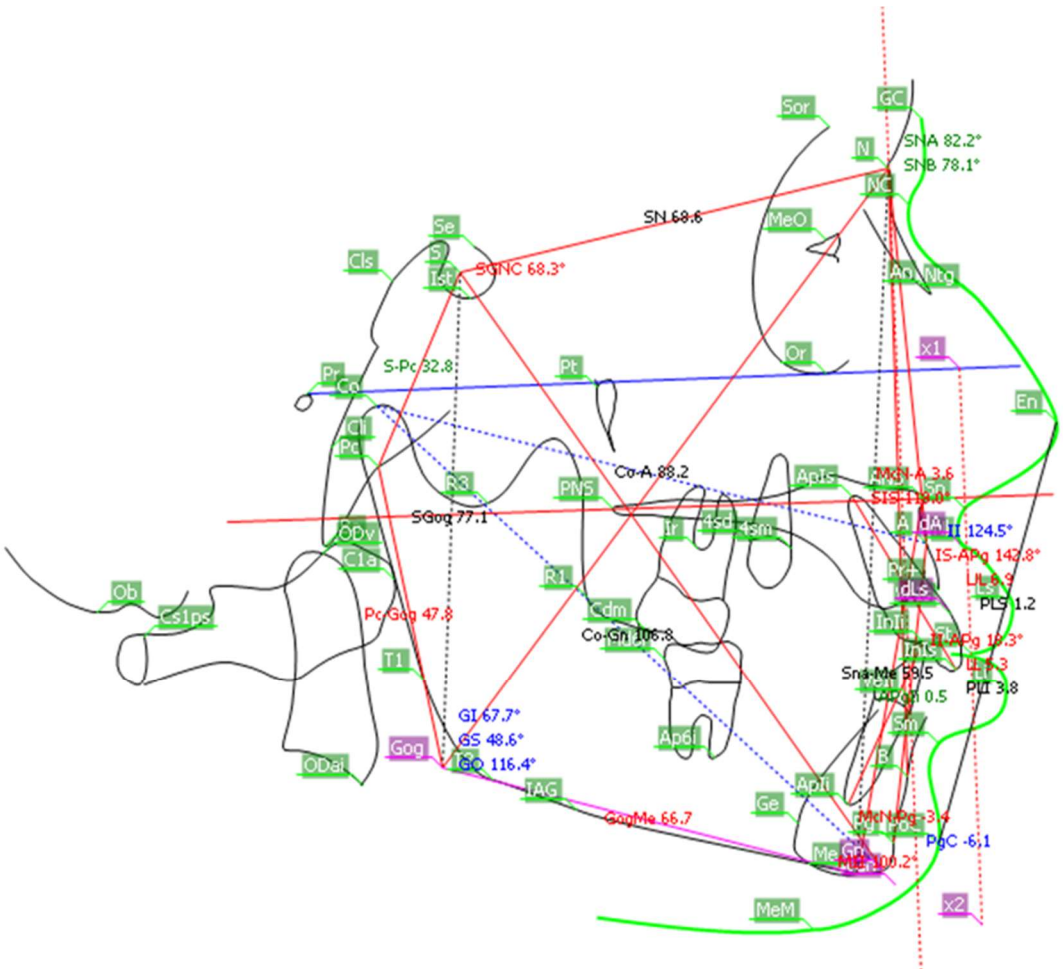



**Fig. 5** *Cephalometric analysis after treatment T1 - treatment group (example).*

according to Angle (7) was achieved and a further slight hyper-correction was obtained, the pendulum with the distalizing springs deactivated appropriately with the aid of a Weingart forceps (the distalizing spring is extracted from the palatal support lane of the band and then slightly bent at the level of the end of the helix so as to be passive once repositioned) was left in position as restraint up to a year from the beginning therapy to stabilize the position of the first upper molar. The distance between the first upper molar and the second upper deciduous molar was detected by a caliper at the end of the active distalization therapy.

Then the position variation of the first upper molar and second upper premolar was analyzed by performing a new cephalometry on the X-rays taken at the end of the semester (T1), first of all detecting their position in the space with respect to the Frankfurt plane (PFH) and its perpendicular on Pt (PTERION), and secondly by performing three overlaps between the pre and post treatment cephalometries on the cranial plane (NS), on the maxillary plane (Sna-Snp) and on the mandibular plane (Me-Go) following the Bussick and Mcnamara method (21) *(Fig.4c,5)*. The radiographic examinations were all performed at the same radiological center also requiring that the patient's head be kept with a fixed gaze towards the horizon, therefore keeping it parallel to the floor so as not to have alterations given by the inclination of the cervical spine. The Frankfurt plan was thus parallel to the ground thus avoiding distortions in the production of the images favoring their reproducibility. The differences in the position in space with respect to the Frankfurt Plan and the structural variations on the basis of the three reference planes were then calculated for the upper first molar and especially for the second upper premolar, then reported in summary tables *(Tab. II)*.

**Table II.** *Treated patients T1.*

| | *1p* | *2p* | *3p* | *4p* | *5p* | *6p* |
|---|---|---|---|---|---|---|
| *SNA°* | 77.6 | 88.7 | 85 | 82.1 | 82.2 | 79.3 |
| *SNB°* | 72.2 | 81.6 | 79.5 | 75.2 | 78.5 | 75.5 |
| *SNPg°* | 73.8 | 82 | 80.2 | 76.8 | 80.5 | 76.3 |
| *ANB°* | 5.4 | 7.1 | 5.5 | 6.9 | 3.7 | 3.8 |
| *WITS mm* | 4.9 | 5.4 | 5.6 | 4.9 | 3.3 | 3.9 |
| *Co-A mm* | 77.1 | 74.2 | 78.2 | 71.1 | 88.4 | 79.3 |
| *Co-Gn mm* | 97.8 | 85.8 | 89.1 | 85.8 | 98.9 | 87.9 |
| ***6+ mm – Pt ⊢ PFH*** | **8.5** | **8.3** | **6.2** | **7** | **7.6** | **3.9** |
| ***5+ mm – Pt ⊢ PFH*** | **30.5** | **26.7** | **24.8** | **27.5** | **16.4** | **21.4** |
| *S-N^Mx°* | 10.2 | 9 | 6.7 | 14.2 | 6.4 | 8.6 |
| *S-N^Md °* | 33.6 | 33 | 28.3 | 37.6 | 24.9 | 38.1 |
| *SNA-Me mm* | 58.9 | 50 | 54.9 | 54.9 | 53.1 | 59 |
| *PFH/Mx°* | 4.4 | 4.5 | 2.1 | 3.4 | 5.1 | 4.1 |
| *PFH/Occ°* | 9.4 | 10.4 | 12.1 | 14.8 | 7.6 | 10.4 |
| *PFH/Md°* | 22.7 | 21.3 | 24.4 | 25.4 | 19.2 | 24.7 |
| *Mx^Md°* | 26.8 | 25 | 21.8 | 32.4 | 22.9 | 34 |
| ***6+ mm - PFH*** | **30.5** | **26.4** | **28** | **35.5** | **30.1** | **31.5** |
| ***5+ mm - PFH*** | **27.2** | **23.7** | **26.5** | **34.2** | **27.6** | **30** |
| *Poligono di Biork°* | 395.6 | 391.4 | 389.3 | 392.6 | 387.9 | 393.2 |
| *Afp/Afa %* | 57.8 | 55.8 | 57.8 | 54.8 | 60.7 | 55.1 |
| *Is^Mx°* | 109.2 | 121.3 | 111.7 | 118.2 | 122.5 | 115.1 |
| *Iinf^Md°* | 102.2 | 107.2 | 94.7 | 100.2 | 99.7 | 92.5 |
| *Ovj mm* | 3.7 | 4.3 | 6.9 | 6.7 | 3.9 | 2 |
| *Ovb mm* | 0.5 | 0.5 | 3 | 1.5 | 2.7 | 2 |

The last radiographic check was performed one year later (T2) to be able to appreciate exactly the natural distalization of the dental germ of the second upper premolar and its gradual stabilization during the eruption, finally comparing the results of the control group with the group treated *(Fig.6)( Tab.III,V)*.

Periodontal and teeth root rx analysis: rx exam simple evaluation at T0, T1 and T2 of first upper molar, first and second upper premolar periodontal area and root development. Statistical analysis: the statistical analysis of the averages of the positional values in the space of the first upper molar and the second upper premolar, sagittally and vertically, was performed using the Parametric Student T Test *(Tab. VI)*.

## RESULTS

Considering clinical and cephalometric results obtained at time T1 and T2 in the treated group, once the distalization phase of the equipment under examination has been completed, it is possible to make some technical-practical considerations. The general picture obtained through the overlaps on the cranial base, on the maxillary and mandibular plane according to the Bussick and Mc Namara method does not vary particularly (16). The skeletal class tends not to a particularly marked improvement (about + 1° for ANB) as well as the divergence that increases slightly both at maxillofacial level (about + 3° for Bjork Polygon) and at oral level (+ 1° for Mx-Md) determined by the distal displacement of the masticatory fulcrum and by the occlusal lifts on the deciduous molars but compensated by the use of class II elastic bands. The skeletal measurements of the jawbones also remain practically unchanged since the patients are still in the infantile phase with limited growth while the lower and upper incisors are slightly inclined (about +3°). Finally, a downward

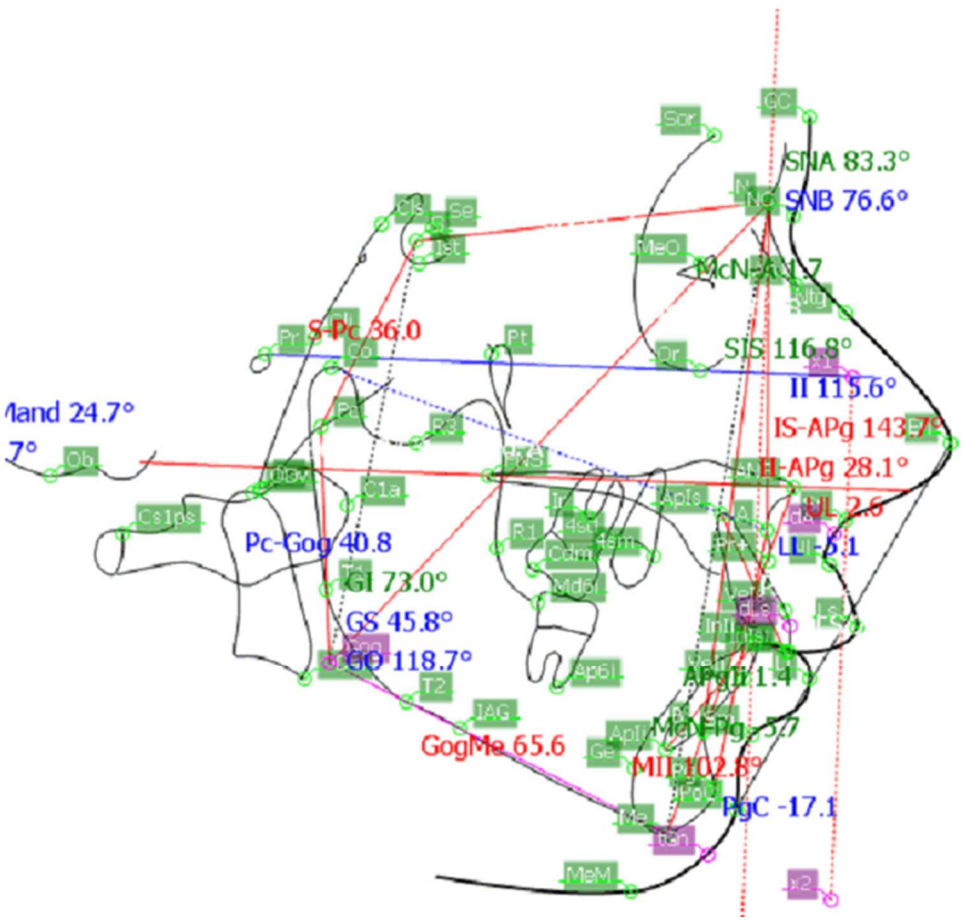



**Fig. 6.** *Cephalometric analysis after treatment T2 - treatment group (example).*

**Table III** *Treated patients T2.*

| | *1p* | *2p* | *3p* | *4p* | *5p* | *6p* |
|---|---|---|---|---|---|---|
| *SNA°* | 78.6 | 87.7 | 85.3 | 83.1 | 83.2 | 80.3 |
| *SNB°* | 74.2 | 82.6 | 80.5 | 78.2 | 80.5 | 76.3 |
| *SNPg°* | 75.8 | 83 | 81.2 | 79.8 | 81.5 | 77.3 |
| *ANB°* | 4.4 | 5.1 | 4.8 | 5.9 | 2.7 | 4 |
| *WITS mm* | 3.9 | 4.4 | 4.6 | 4.9 | 3.8 | 3.2 |
| *Co-A mm* | 79.1 | 77.7 | 79.6 | 75.9 | 89.7 | 82.6 |
| *Co-Gn mm* | 99.4 | 88.9 | 93.7 | 92.1 | 103.1 | 94.2 |
| ***6+ mm – Pt I- PFH*** | **8.4** | **8.1** | **6.1** | **6.9** | **7.5** | **3.9** |
| ***5+ mm – Pt I- PFH*** | **30** | **26.2** | **24.2** | **27.1** | **15.9** | **21** |
| *S-N^Mx°* | 10.2 | 9 | 6.7 | 14.2 | 6.4 | 8.6 |
| *S-N^Md °* | 33.6 | 33 | 28.3 | 37.6 | 24.9 | 38.1 |
| *SNA-Me mm* | 59.9 | 53 | 58.9 | 57.9 | 55.1 | 65 |
| *PFH/Mx°* | 4.4 | 4.5 | 2.1 | 3.4 | 5.1 | 4.1 |
| *PFH/Occ°* | 9.4 | 10.4 | 12.1 | 14.8 | 7.6 | 10.4 |
| *PFH/Md°* | 22.7 | 21.3 | 24.4 | 25.4 | 19.2 | 24.7 |
| *Mx^Md°* | 26.8 | 25 | 21.8 | 32.4 | 22.9 | 34 |
| ***6+ mm - PFH*** | **30.3** | **26.5** | **28.1** | **35.3** | **29.9** | **31.4** |
| ***5+ mm - PFH*** | **27** | **23.1** | **26.2** | **34** | **27.2** | **29.9** |
| *Poligono di Biork°* | 394.1 | 392.7 | 388.8 | 393.2 | 386.1 | 394.9 |
| *Afp/Afa %* | 58.1 | 54.3 | 56.4 | 55.1 | 61.2 | 53.2 |
| *Is^Mx°* | 108.2 | 120.3 | 110.7 | 117.2 | 121.5 | 114.1 |
| *Iinf^Md°* | 101.2 | 106.2 | 93.7 | 101.2 | 98.7 | 91.5 |
| *Ovj mm* | 3.1 | 4.1 | 6.2 | 6.3 | 3.4 | 2.1 |
| *Ovb mm* | 0.6 | 0.7 | 3.1 | 1.7 | 2.4 | 2.2 |

**Table IV** *Control patients T0.*

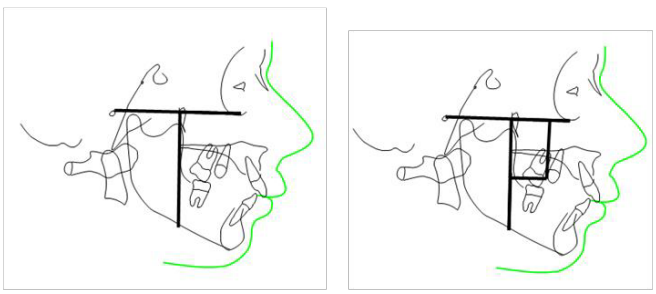
| | *1p* | *2p* | *3p* | *4p* | *5p* | *6p* |
|---|---|---|---|---|---|---|
| *SNA°* | 78.6 | 87.7 | 85.3 | 83.1 | 83.2 | 80.3 |
| *SNB°* | 74.2 | 82.6 | 80.5 | 78.2 | 80.5 | 76.3 |
| *SNPg°* | 75.8 | 83 | 81.2 | 79.8 | 81.5 | 77.3 |
| *ANB°* | 4.4 | 5.1 | 4.8 | 5.9 | 2.7 | 4 |
| *WITS mm* | 3.9 | 4.4 | 4.6 | 4.9 | 3.8 | 3.2 |
| *Co-A mm* | 79.1 | 77.7 | 79.6 | 75.9 | 89.7 | 82.6 |
| *Co-Gn mm* | 99.4 | 88.9 | 93.7 | 92.1 | 103.1 | 94.2 |
| ***6+ mm – Pt I- PFH*** | **8.4** | **8.1** | **6.1** | **6.9** | **7.5** | **3.9** |
| ***5+ mm – Pt I- PFH*** | **30** | **26.2** | **24.2** | **27.1** | **15.9** | **21** |
| *S-N^Mx°* | 10.2 | 9 | 6.7 | 14.2 | 6.4 | 8.6 |
| *S-N^Md °* | 33.6 | 33 | 28.3 | 37.6 | 24.9 | 38.1 |
| *SNA-Me mm* | 59.9 | 53 | 58.9 | 57.9 | 55.1 | 65 |
| *PFH/Mx°* | 4.4 | 4.5 | 2.1 | 3.4 | 5.1 | 4.1 |
| *PFH/Occ°* | 9.4 | 10.4 | 12.1 | 14.8 | 7.6 | 10.4 |
| *PFH/Md°* | 22.7 | 21.3 | 24.4 | 25.4 | 19.2 | 24.7 |
| *Mx^Md°* | 26.8 | 25 | 21.8 | 32.4 | 22.9 | 34 |
| ***6+ mm - PFH*** | **30.3** | **26.5** | **28.1** | **35.3** | **29.9** | **31.4** |
| ***5+ mm - PFH*** | **27** | **23.1** | **26.2** | **34** | **27.2** | **29.9** |
| *Poligono di Biork°* | 394.1 | 392.7 | 388.8 | 393.2 | 386.1 | 394.9 |
| *Afp/Afa %* | 58.1 | 54.3 | 56.4 | 55.1 | 61.2 | 53.2 |
| *Is^Mx°* | 108.2 | 120.3 | 110.7 | 117.2 | 121.5 | 114.1 |
| *Iinf^Md°* | 101.2 | 106.2 | 93.7 | 101.2 | 98.7 | 91.5 |
| *Ovj mm* | 3.1 | 4.1 | 6.2 | 6.3 | 3.4 | 2.1 |
| *Ovb mm* | 0.6 | 0.7 | 3.1 | 1.7 | 2.4 | 2.2 |

**Table V.** *Control patients T2.*

| | *1p* | *2p* | *3p* | *4p* | *5p* | *6p* |
|---|---|---|---|---|---|---|
| *SNA°* | 78.5 | 81.3 | 81.4 | 88.6 | 87.5 | 78.6 |
| *SNB°* | 74.2 | 75.3 | 74.1 | 80.2 | 78.3 | 73.4 |
| *SNPg°* | 75.8 | 76 | 75.2 | 81.3 | 80.3 | 74.2 |
| *ANB°* | 4.3 | 11 | 7.3 | 8.4 | 9.2 | 5.2 |
| *WITS mm* | 4 | 6.3 | 7.2 | 6.1 | 6.2 | 4.6 |
| *Co-A mm* | 73.1 | 64.2 | 70.8 | 65.5 | 82.6 | 69.3 |
| *Co-Gn mm* | 94.9 | 78 | 79.5 | 78.8 | 92.3 | 79.5 |
| ***6+ mm – Pt I- PFH*** | **16.5** | **16.8** | **13.2** | **10.7** | **13.7** | **7.2** |
| ***5+ mm – Pt I- PFH*** | **31.1** | **32.3** | **25.9** | **26.8** | **19** | **23.9** |
| *S-N^Mx°* | 7.2 | 12.7 | 14.6 | 12.3 | 7.6 | 8.7 |
| *S-N^Md °* | 34.7 | 45.7 | 29.4 | 39.9 | 30.2 | 36.8 |
| *SNA-Me mm* | 56 | 45.9 | 46 | 49.3 | 56.9 | 53.8 |
| *PFH/Mx°* | 4.9 | 8.1 | 4.1 | 3.2 | 7.1 | 5.3 |
| *PFH/Occ°* | 9.5 | 11.1 | 11.4 | 14.1 | 8.3 | 10 |
| *PFH/Md°* | 22.4 | 19.1 | 23.4 | 25.1 | 17.2 | 23.2 |
| *Mx^Md°* | 26.2 | 27.3 | 19.3 | 29.6 | 25.6 | 31 |
| ***6+ mm - PFH*** | **31.7** | **26.8** | **28.3** | **35.6** | **33.3** | **34.8** |
| ***5+ mm - PFH*** | **28.4** | **25.8** | **28.7** | **34.3** | **26.8** | **31.4** |
| *Poligono di Biork°* | 393.1 | 387.2 | 389.9 | 397.1 | 386.1 | 396.1 |
| *Afp/Afa %* | 63.8 | 58.8 | 67.3 | 68.6 | 67.8 | 59 |
| *Is^Mx°* | 112.4 | 113.3 | 119.9 | 119.1 | 125.6 | 109.1 |
| *Iinf^Md°* | 96.8 | 92 | 100.1 | 94.1 | 101.9 | 97.8 |
| *Ovj mm* | 4.3 | 5.4 | 7.9 | 8.1 | 8.6 | 5.9 |
| *Ovb mm* | 0.9 | 1.3 | 1.5 | 2.7 | 0.8 | 0.9 |

**Table VI.** *Comparison of treated patients and control patients T0, T1, T2.*

VERTICAL - SAGITTAL ANALISYS 6+ / 5+ than PFH and Pt I- PFH



COMPARISON BETWEEN TREATED PATIENTS AND CONTROLS T0,T1,T2

| | VERTICAL CHANGE (T0-T1, T1-T2) mm | SAGITTAL CHANGE (T0-T1, T1-T2) mm |
|---|---|---|
| 6 ± | T1: 1,4 TREATED GROUP<br>T2: 0,1 TREATED GROUP<br>(ABSENCE OF SIGNIFICANT CHANGE IN CONTROL GROUP) | T1: 5 TREATED GROUP<br>T2: 0,1 TREATED GROUP<br>(ABSENCE OF SIGNIFICANT CHANGE IN CONTROL GROUP) |
| 5 ± | T1: 1,6 TREATED GROUP<br>T2: 0,3 TREATED GROUP<br>(ABSENCE OF SIGNIFICANT CHANGE IN CONTROL GROUP) | T1: 1,8 TREATED GROUP<br>T2: 0,5 TREATED GROUP<br>(ABSENCE OF SIGNIFICANT CHANGE IN CONTROL GROUP) |

and backward (clockwise) variation of the occlusal and mandibular plane is observed .

## DISCUSSION

These variations reflect the effects of distalization found in the literature (17-46). The complete cephalometric analysis involves considerations, to be made following the use of the pendulm in childhood, in accordance with the work performed by Bussick and Mc Namara (16). Multiple aspects can be highlighted specifically at the spatial position of the first upper molar and the second upper premolar.

Firstly, observing the average distal displacement value (5 mm) of the first upper molar of the patients undergoing the experiment, it can be seen that it had a rapid, effective, statistically significant variation in position of the same level as those found in the literature infantile (17) while higher than the distalization obtainable in the adult patient (46). The aforementioned variation was certainly favored by the absence of opposition from the upper second molar even in the early stages of formation of the crown structure given the age of the patients (8-8.5 years) and therefore absolutely unable to offer resistance to movement distal upper first molar (41, 42). In the same way, going to verify the variation of the post-treatment position (T1) vertical (1.4mm) of the first upper molar we can affirm how the inclination that it undergoes from the thrust of the pendulum spring is very limited, not statistically significant, allowing thus a predominantly corporal distalization of the element. Secondly, considering the average post-treatment (T1) vertical (1.6mm) and saggital (1.8mm) displacement values of the second upper premolar, we cannot yet speak of a statistically significant displacement, but it can be stated that, being very similar, they do not yet testify to a well-defined body shift but certainly a distal variation of the inclination of the axis of the dental element observation which moreover is even more evident from the comparison between the pre and post treatment orthopantomographies.

The hypothesis of a natural distalization released from the gubernaculus dentis of the upper second deciduous molar is therefore confirmed. At time T2 the body displacement of the germ of the second upper premolar is confirmed distal to the second deciduous upper molar obtaining its stabilization, thanks to the longer time guaranteed by the transectal fibers to exert traction on the second upper premolar and to the subsequent distal displacement of the second deciduous molar upper once released from the occlusal support at time T1. It also highlights the progressive variation of the dental axis of the germ of the second upper premolar passing from time T0, T1 and T2 contrary to the control group where in addition to not having bodily displacements of the first upper molar but above all of the dental germ of the second upper premolar there is no it is not even a variation of the latter's axis. Finally, RX exam simple evaluation at T0, T1 and T2 of first upper molar, first and second upper premolar periodontal area and root development show inexistent periodontal inflammation on second and first upper premolar germs because of exploiting deciduous teeth. Periodontal inflammation and teeth root stress on first upper molar of treatment group, after RX analysis, appear limited compared to control group because of the advance orthodontic interceptive treatment during a previous stage of first upper molar root development.

Furthermore, on a practical level, it is right to highlight how the use of fixed distalization equipment at this age reduces the risk of collaboration to zero, given the obvious difficulty of giving a comprehensive explanation to the young patient (17). The choice of childhood therefore gave problems initially in accepting such a complex piece of equipment to the child trying to draw his attention to the importance that its use had and the maintenance of its integrity. Subsequently, as the therapy progressed, a relationship of trust was established with the patient which ensured the success of the distalization therapy. Besides the choice of this period of age has safeguarded the permanent dentition from the risk of carious formations, and in the cases in which they were created, they concerned only the deciduous dentition. In the final analysis, the chosen period, being in the childhood/ pre-adolescent phase, made it easier to create a relationship of trust with the

little patient who, although managing to understand little the need for therapy, applied it more so that it was effective.

Following the comparison between the Control group and the Pilot group treated, observing the average of the movement of the second vertical (1.6mm) and sagittal (2.5mm) upper premolar in the pilot group of the experimentation, it is possible to declare the radiological evidence of the variation in distal sense of the inclination of the dental axis between the time T0 to T1 and the stabilization of the shift occurred between the time T1 and T2. Beside periodontal inflammation and teeth root stress appears inexistent on second and first upper premolar germs due to exploiting deciduous teeth and results limited on first upper molar of treatment group compared to control group because of the advance orthodontic interceptive treatment during a previous stage of first upper molar root development. Finally, it is possible to highlight the absence of this movement of the second upper premolar in the control group taken into consideration, thus confirming that the improvement obtained in the pilot experimentation group is absolutely related to the therapy performed by improving the dental class ratio, the ex-inclination of the upper incisor group and the mode of eruption of the upper permanent dentition of the lateral sectors main purpose of the research carried out starting from the provoking of the detachment of the germ of the second upper premolar from the gubernaculus dentis linked to the second upper deciduous molar.

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# New trends in adjunctive treatment and diagnosis in Medication-related osteonecrosis of the jaw: A 10-year review

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**Medication-related osteonecrosis of the jaw (MRONJ) is a major disease under study for over the last twenty years. Different classifications have been proposed and many therapies for the different stages have been applied. The evolution of treatments lead to an increasingly conservative approach. Numerous adjuvant treatments have been proposed in the last decade. All these complementary treatments have been proposed mainly to resolve or reduce the painful stress, predominantly caused by bacterial infection, simplifying the wound healing process and improving patients' compliance. Nowadays "secondary" treatments, such as autologous platelet concentrates (APCs, more specifically PRP, PRGF or PRF), hyperbaric oxygen (HBO), Auto/tetracycline fluorescence-guided bone surgery (AF-GBS/TF-GBS), medical drugs like teriparatide or the combination between pentoxifylline and tocopherol, fluorodeoxyglucose positron emission tomography (FDG-PET), laser and/or low-laser therapy and ozone therapy are more or less well documented and known considering their clinical effectiveness. The aim of the present review is the evaluation of the quantity and quality of scientific studies concerning this specific topic.**

At the beginning of 19th century first scientific publications appeared concerning serious pathologies, named "*possy jaw*", involving the upper and lower maxillary bone structures in specialized workers in the extraction and/or processing phosphorus (miners and workers in factories used to manufacture matches) (1). Originally noted as early as 2002 (2) the condition was first described in detail in 2003 when Marx et al. (3) published the first paper in which this pathology became known internationally and will be called Osteonecrosis of the Jaw (ONJ). A few years later it highlighted a very high incidence of this pathology (compared to the healthy population) in patients treated for various needs (e.g. osteoporosis, Paget disease, bone metastases, osteopetrosis, multiple myeloma) with bisphosphonates or undergo to radiation therapy. This correlation led scientific community to coin respectively the term Bisphosphonate-Related Osteonecrosis of the Jaws (BRONJ) and Osteo Radionecrosis of the Jaw (ORNJ). Furthermore, recent studies showed as other drugs categories (monoclonal antibody with anti-resorptive activity, anti-angiogenetic drugs (anti-VEGF), tirosin-Kinasi inhibitors, mTOR inhibitors) can cause the same disease, leading to a modification of the previous acronym in Medication-Related Osteonecrosis of the Jaws (MRONJ) by the American Association of Oral and Maxillofacial Surgeons (AAOMS) (4-5).

The MRONJ refers to a condition characterized

*Key words: jaw osteonecrosis, bisphosphonate, therapies, literature review*

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by exposure of bone in the mandible or maxilla persisting for more than 8 weeks in a patient treated or in treatment with bisphosphonates with negative history of radiation therapy to the jaws (3-6). Diagnostic criteria for MRONJ were developed based on the pharmacological history as well as clinical and radiographic features (7). The MRONJ staging system, developed in 2006 by Ruggiero et al. and subsequently update in 2104 by AAOMS (4-5), is reported in Table I.

The classification in a specific stage cannot ignore an extreme accurate intra and extra oral clinical examination and an evaluation with radiographic supports (8); orthopantomography is the first level radiographic diagnostic support, followed by Computerized Tomography (CT) and Cone-Beam CT (CBCT); to obtain high-quality tomographic images, that exhibits a higher resolution in the alveolar bone and the jawbones (9); Magnetic Resonance Imaging (MRI) can be very useful (10-11). Recently the single-photon emission computed tomography (SPECT) has been used for localization of physiological changes in the bone and it appears to be sensitive but not specific (11).

In the assessment of osteoporosis' severity (and consequently the dosage, type and method of administration of the BPs), a quantitative haematic evaluation of two protein markers was introduced: P1NP (procollagen type 1 amino-terminal propeptide) and CTX (cross-linked C-telopeptide of type I collagen). These two parameters are measured before the start of therapy at time 0 and at 3 months, allowing to promptly verify the validity of the therapy and adherence to the treatment (12-13). Other widely used means in index calibration of osteoporosis and osteopenia's therapy with BPs are DEXA scan (dual energy x-ray absorptiometry) which yields to BMD (bone mineral density) values (14-16).

Although there are still no clear guidelines or a unique clinical protocol totally shared by the international scientific community, some operative strategies in osteonecrosis' case are worldwide shared by numerous clinicians. Summarizing in literature are reported: preferred conservative,

**Table I**. *MRONJ staging system as updated by AAOMS in 2014.*

| ***Stage*** | ***Clinical findings*** |
|---|---|
| *At-risk category* | No apparent necrotic bone in patients who have been treated with either oral or IV bisphosphonates |
| *Stage 0* | No clinical evidence of necrotic bone, but non-specific clinical findings, radiographic changes, and symptoms |
| *Stage 1* | Exposed and necrotic bone, or fistulae that probes to the bone in patients who are asymptomatic and have no evidence of infection |
| *Stage 2* | Exposed and necrotic bone, or fistulae that probes to the bone, associated with infection as evidenced by pain and erythema in the region of the exposed bone, with or without purulent drainage |
| *Stage 3* | Exposed and necrotic bone or a fistula that probes to bone in patients with pain, infection, and one or more of the following: exposed and necrotic bone extending beyond the region of alveolar bone (i.e., inferior border and ramus in the mandible, maxillary sinus, and zygoma in the maxilla) resulting in pathologic fracture, extraoral fistula, oral-antral/oral-nasal communication or osteolysis extending to the inferior border of the mandible of sinus floor |

endodontic maintenance therapies and extreme care of professional and home oral hygiene, avoiding traumatic interventions such as toilet or surgical curettage if possible, less extensive surgeries as possible, avoiding any traumatization for the surrounding structures, intra-operatory disinfection with saline solution, accurate management of soft tissues without stress or tension, elimination of sharp edges, closure by first intention with eventual flap passivation, double-layer suture, use of mouthwash and painkillers after surgeries, coverage or double antibiotic coverage variable from 10 days before to 7 days after, weekly follow up. In absence of anamnestic allergy, the first-choice antibiotics are clavulanate amoxicillin and metronidazole (4, 14, 17-23). Aim of the present literature review is the evaluation of the possible utility of adjunctive therapies in the treatment and diagnosis of MRONJ.

## MATERIALS AND METHODS

This review study followed the PRISMA statement guidelines (24) and was conducted to analyze all publications related to adjunctive treatments on MRONJ therapy. Focused questions: what are today's additional treatments in the therapy of MRONJ? How many and what types of studies have been conducted on these treatments in the past 10 years? In the light of these data, could a first assessment be made of how much they are known and used in clinical practice by the scientific community?

Information sources: an electronic research was performed through MEDLINE (PubMed) databases. In addition, in order to further increase the number of eligible articles and not to skip potentially relevant publications, an analysis of the reference list of the main literature reviews and studies performed on the topic of interest was carried out. Search strategy: the electronic search was conducted by three independent examiners to minimize reviewer biases, applying the following filters: human studies, date of publication starting 01/01/2010 up to the time of the search (April 2020), and articles exclusively published in English. The first search strategy made use of the following terms: "adjunctive treatment MRONJ" or "adjunctive therapy MRONJ" or "adjunctive treatment ONJ" or "adjunctive therapy ONJ" or "adjunctive treatment BRONJ" or "adjunctive therapy BRONJ".

The first screening directly made on PubMed identified 75 papers, 54 on humans, 53 written in English, 48 published from 1st January 2020, 24 removing the duplicates and by a cross-checking in the different categories (in order to eliminate further duplications) the final result was 20 eligible papers (see Table II).

After removing duplicate and checking their pertinence, the total of evaluable publications was 18 (25-42). All the papers were analyzed by reading the abstract or, if it was not clear or incomplete, the full text. Nine complementary/additional treatments to usual therapy in osteonecrosis of the jaws were identified (see Table III). The adjunctive treatments are:

**Table II**.

| *Categories** | *n° articles* | *on human* | *in English* | *from 1.1.2010* | *Total sectorial papers*** | *Total eligible papers* |
|---|---|---|---|---|---|---|
| *Atr MRONJ* | 10 | 6 | 6 | 6 | 6 | |
| *Ath MRONJ* | 10 | 6 | 6 | 6 | | |
| *Atr ONJ* | 10 | 8 | 8 | 5 | 5 | 20 |
| *Ath ONJ* | 9 | 6 | 5 | 5 | | |
| *Atr BRONJ* | 18 | 14 | 14 | 13 | 13 | |
| *Ath BRONJ* | 18 | 14 | 14 | 13 | | |

*Atr= Adjunctive Treatment; Ath= Adjunctive Therapy; MRONJ= Medicament-Related Osteonecrosis of the Jaw; ONJ= Osteonecrosis of the Jaw; BRONJ= Bisphosphonate-Related Osteonecrosis of the Jaw.*

- APCs (Autologous Platelet Concentrates or hemoderivates, i.e. PRP, PRGF or PRF).
- HBO (Hyperbaric Oxygen).
- AF-GBS/TF-GBS (Auto/Fluorescence-guided bone surgery; Tetracycline/Fluorescence-guided bone surgery).
- Antimicrobical photodynamic therapy.
- Teriparatide.
- FDG-PET (Fluorodeoxyglucose Positron Emission Tomography).
- Pentoxifylline/Tocopherol.
- Laser and/or low-laser therapy.
- Ozone (O3).

The second step in screening was performed by searching for all 9 correlation items, as previously searched, with the terms "treatment", "MRONJ", "ONJ" and "BRONJ" (Table IV). For a better research about the term "APCs" it has been further divided into 3 subgroups (PRF, PRP and PRGF) (Table V).

*Eligibility criteria*

The following inclusion and exclusion criteria were applied to carry out the study selection. Inclusion criteria:

- All kind of publication: Randomized-controlled clinical trials (RCT), Clinical trials (CT); Review (R); Longitudinal study (LS); Retrospective study (RS); Pilot study (PS); Case series (CS) and Case report (CR).
- "in vivo" studies, on humans.
- Date of publications from 01.01.2010.
- Original language English.
- Close relevance to MRONJ therapy (this point was discussed by examinators and accepted only if all 3-examiner agreed).
- Exclusion criteria:
- "In vitro" studies.
- Animal studies.
- Retrospective studies, case reports, case series, and systematic reviews.
- Date of publication before 01.01.2010.
- All original language, not in English.

Study selection: titles deriving from the research previously highlighted have been reviewed (identification) by three examiners. In case of disagreement, the three reviewers discussed each case jointly, to get to a final decision concerning inclusion or exclusion. The potentially useful articles through the analysis of the title were only then selected for a deeper investigation by firstly reading the abstract. In the examination of abstract (screening), attention was paid to assess the compliance of the study with the inclusion criteria. The selected studies were downloaded in digital or paper version and submitted to the reading of the full text (eligibility). With this procedure only articles that conformed to the aforementioned criteria were included (included).

The data extraction was performed filling in a table (see Table V) with complementary treatments' name, typology of the study (RCT, CT, R, LS, RS, PS, CS, CR), total number of publication, number of discarded publication (not closely inherent for the purpose of the current study), total useful number of publication. Quality assessment. The following parameters were adopted for the evaluation of risk of bias: random sequence generation and allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective reporting (reporting bias), and other possible reasons for bias. Once these articles have been selected, they were further checked according to the same inclusion and exclusion criteria motioned above.

## RESULTS

All results are summarized in Table VI and Fig. 3. First of all, in Fig. 1 the observation on how the number of articles concerning the 8 additional treatments under consideration in decreasing order are: laser therapy (twenty-three), teriparatide (twenty two), APCs (twenty), hyperbaric oxygen therapy (thirteen), ozone therapy (twelve), use of pentoxicylline/tocopherol (five), AF-GBS/TF-GBS (four) and FDG-PET (three). This data has the function of understanding passively through publications number whether a treatment has been

**Table III**. *Adjunctive treatments in relation of the selected paper.*

| | | Adjunctive treatments | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Authors | Paper's Title | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
| Poli PP et al. (2019) (25) | Adjunctive application of antimicrobial photodynamic therapy in the prevention of medication-related osteonecrosis of the jaw following dentoalveolar surgery: A case series. | ■ | | | | | | | |
| Quaisi M et al. (2017) (26) | Bone Margin Analysis for Osteonecrosis and Osteomyelitis of the Jaws. | | | | | | | ■ | |
| Beth-Tasdogan NH et al. (2017) (27) | Interventions for managing medication-related osteonecrosis of the jaw. | | | ■ | ■ | | | | |
| Jung J et al. (2017) (28) | Short-Term Teriparatide and Recombinant Human Bone Morphogenetic Protein-2 for Regenerative Approach to Medication-Related Osteonecrosis of the Jaw: A Preliminary Study. | | ■ | | | | | | |
| Fleisher KE et al. (2016) (29) | Does Fluorodeoxyglucose Positron Emission Tomography With Computed Tomography Facilitate Treatment of Medication-Related Osteonecrosis of the Jaw? | | | | | | | | ■ |
| Owosho AA et al. (2016) (30) | Pentoxifylline and tocopherol in the management of cancer patients with medication-related osteonecrosis of the jaw: an observational retrospective study of initial case series. | | | | | | ■ | | |
| Silva LF et al. (2016) (31) | Surgical management of bisphosphonate-related osteonecrosis of the jaws: literature review. | ■ | | ■ | ■ | ■ | | | |
| Rollason V et al (2016) (32) | Interventions for treating bisphosphonate-related osteonecrosis of the jaw (BRONJ). | | ■ | ■ | ■ | | | | |
| Anitua E et al.(2016) (33) | PRGF exerts a cytoprotective role in zoledronic acid-treated oral cells. | | | ■ | | | | | |
| Goodday RH. (2015) (34) | Preventive Strategies for Patients at Risk of Medication-related Osteonecrosis of the Jaw. | | | | ■ | ■ | | | |
| Fliefel R et al. (2015) (35) | Treatment strategies and outcomes of bisphosphonate-related osteonecrosis of the jaw (BRONJ) with characterization of patients: a systematic review. | ■ | | ■ | ■ | ■ | | | |
| Del Fabbro M et al. (2015) (36) | Autologous platelet concentrates for bisphosphonate-related osteonecrosis of the jaw treatment and prevention. A systematic review of the literature. | | | ■ | | | | | |
| Altay MA et al. (2014) (37) | Low-level laser therapy supported surgical treatment of bisphosphonate related osteonecrosis of jaws: a retrospective analysis of 11 cases. | ■ | | | | | | | |
| Ohbayashi Y et al. (2013) (38) | Adjunct teriparatide therapy with monitoring of bone turnover markers and bone scintigraphy for bisphosphonate-related osteonecrosis of the jaw. | | ■ | | | | | | |
| Kwon YD et al. (2012) (39) | Short-term teriparatide therapy as an adjunctive modality for bisphosphonate-related osteonecrosis of the jaws. | | ■ | | | | | | |
| Freiberger JJ et al. (2012) (40) | What is the role of hyperbaric oxygen in the management of bisphosphonate-related osteonecrosis of the jaw: a randomized controlled trial of hyperbaric oxygen as an adjunct to surgery and antibiotics. | | | | ■ | | | | |
| Lee JJ et al. (2011) (41) | Successful treatment of advanced bisphosphonate-related osteonecrosis of the mandible with adjunctive teriparatide therapy. | | ■ | | | | | | |
| Kan B et al. (2011) (42) | Low-level laser therapy supported teeth extractions of two patients receiving IV zolendronate. | ■ | | | | | | | |

*LTh = Laser Therapy; T = Teriparatide; APCs = Autologous Platelet Concentrates or hemoderivates, i.e. PRP,PRGF or PRF; HBO = Hyperbaric Oxygen; $O_3$ = Ozone therapy; P/T = Pentoxifylline/Tocopherol; AF-GBS/TF-GBS = Auto/Fluorescence-guided bone surgery - Tetracycline/Fluorescence-guided bone surgery; FDG-PET = Fluorodeoxyglucose Positron Emission Tomography.*

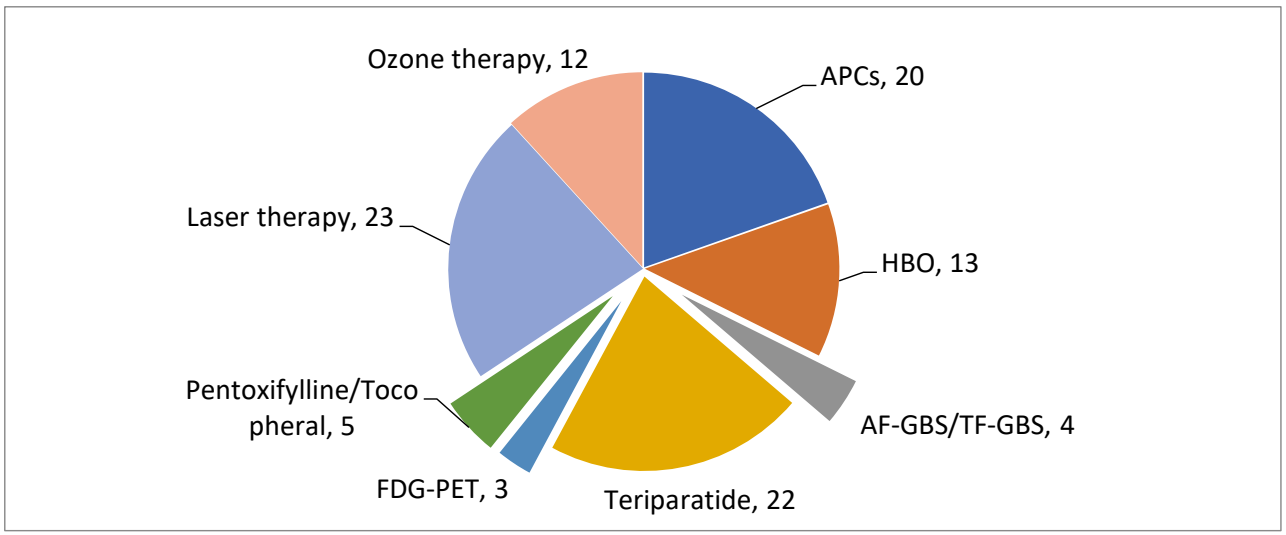


**Fig. 1**. *"Cake" graphic underlines which adjunctive individual category treatment are well known by scientific community (Laser therapy, APCs and Teriparatide) and which ones are less notorious (FDG-PET, AF-GBS/TF-GBS, use of Pentoxifylline/Tocopheral).*

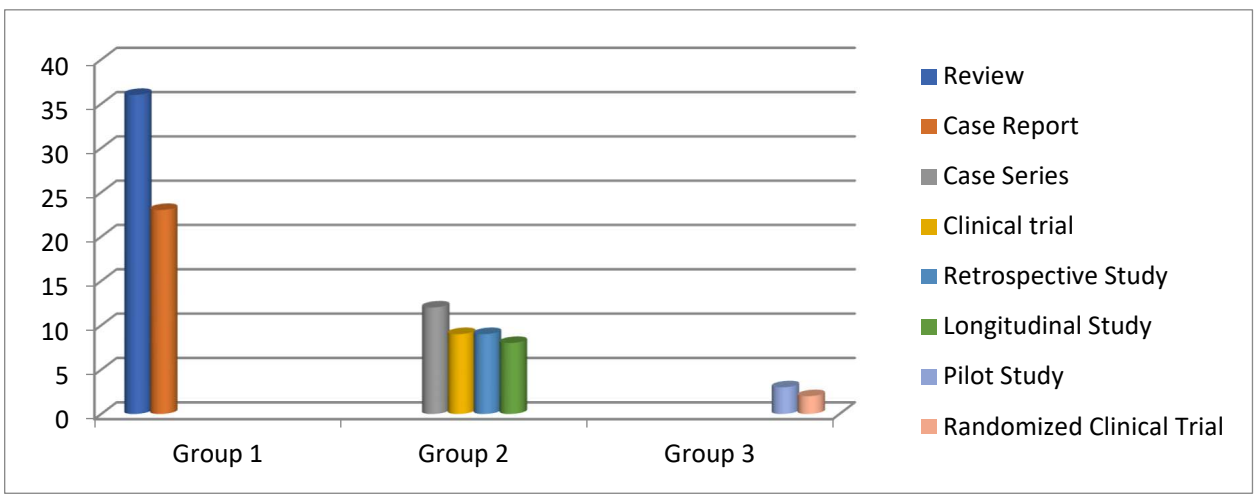


**Fig. 2**. *Numerical distribution of publication by their typology. Group 1: high quantitative; Group 2: medium quantitive; Group 3: low quantitive.*

taken into general scientific community consideration in order of its potential effectiveness.

From this point of view, data can be split into 4 different groups: the first one includes just the laser therapy which is better known and used than other additional treatment in MRONJ. The second one is made of teriparatide and APCs, the third one, progressively less utilized and mentioned in literature, are hyperbaric oxygen and ozone therapy. The last one, the fourth, highlights less known and used procedures to the current state of art in complementary therapy of MRONJ such as pentoxifylline/tocopheral medical drugs, whereas AF-GBS/TF-GBS is used as an aid in the pre-intra surgical phase and FDG-PET in diagnostic phase. Studies such as reviews and case reports (respectively 29 and 18) are more numerous than clinical trials, case series, retrospective studies, longitudinal studies, randomized clinical trials and pilot studies (respectively 9, 9, 7, 4, 2, 2) (Fig. 2).

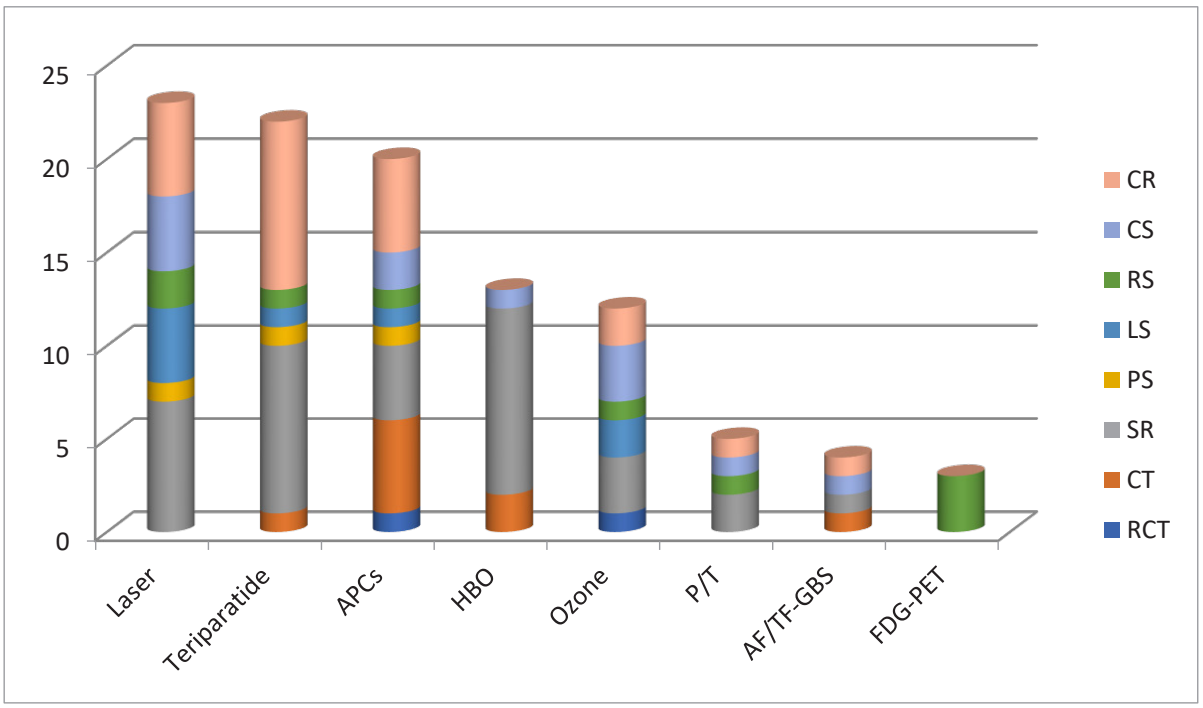


**Fig. 3**. *Results distribution obtained for the 8 adjunctive/complentary treatments for MRONJ therapy and relative quantification by typology of publications.*

**Table IV**.

| | *RCT* | *CT* | *SR* | *PS* | *LS* | *RS* | *CS* | *CR* | *Total* | *Dis-card* | *Total useful* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Laser and/or low-laser therapy* | 0 | 0 | 7 | 1 | 4 | 2 | 4 | 5 | 58 | 35 | 23 |
| *Teriparatide* | 0 | 1 | 9 | 1 | 1 | 1 | 0 | 9 | 23 | 1 | 22 |
| *APCs* | 1 | 5 | 4 | 1 | 1 | 1 | 2 | 5 | 21 | 1 | 20 |
| *HBO* | 0 | 2 | 10 | 0 | 0 | 0 | 1 | 0 | 14 | 1 | 13 |
| *Ozone therapy* | 1 | 0 | 3 | 0 | 2 | 1 | 3 | 2 | 13 | 1 | 12 |
| *Pentoxifylline/Tocopherol* | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 6 | 1 | 5 |
| *AF-GBS/TF-GBS* | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 4 | 0 | 4 |
| *FDG-PET* | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 34 | 31 | 3 |
| ***Summary*** | **2** | **9** | **36** | **3** | **8** | **9** | **12** | **23** | **173** | **71** | **102** |

*HBO=Hyperbaric Oxygen therapy; AF-GBS/TF-GBS=Auto/Fluorescence-guided bone surgery, Tetracycline/ Fluorescence-guided bone surgery; PDG-ET=Fluorodeoxyglucose Positron Emission Tomography.*

## DISCUSSION

Despite progress in the prevention of BRONJ, a specific widely accepted and utilized treatment protocol to manage MRONJ is still missing, as the literature shows (43-48). Summarizing, the MRONJ treatments are referrable to surgical and non-surgical treatments (49-60). In the past, surgical treatments were reserved only for advanced stages of BRONJ, but since 2012, the Italian Society of Oral and Maxillofacial Surgery (SICMF) and the Italian Society of Oral Pathology and Medicine (SIPMO) recommended conservative surgery in lesions belonging to stages 1 and 2. In this regard, from our study we evidenced as, in recent years, an attempt to increasingly adopt a "conservative" approach has been made. Most of the analyzed studies introduced the use of therapy defined as "additional" in association with surgery.

Specifically, additional therapy is referred to as non-invasive treatments, such as cycles of local or systemic antibacterial therapy combined or not, to low level laser therapy, ozone therapy (O3), HBO (Hyperbaric Oxygen therapy), the use of APCcs APCs (Autologous Pletelet Concentrates, such as PRP,PRGF or PRF), AF-GBS/TF-GBS (Auto/

**Table V.**

| APCs | | n° papers | total individual papers | With no duplicates | Total (PRF+PRP +PRGF) | Total (PRF+PRP+PRGF) without duplicates |
|---|---|---|---|---|---|---|
| PRF | tr.MRONJ | 5 | 14 | 11 | 26 | 21 |
| | tr.ONJ | 2 | | | | |
| | tr.BRONJ | 7 | | | | |
| PRP | tr.MRONJ | 1 | 8 | 6 | | |
| | tr.ONJ | 2 | | | | |
| | tr.BRONJ | 5 | | | | |
| PRGF | tr.MRONJ | 3 | 11 | 9 | | |
| | tr.ONJ | 1 | | | | |
| | tr.BRONJ | 7 | | | | |

*APCs= Autologous Pletelet Concentrates; PRF=Platelet-Rich Fibrin; PRP=Pletelet-Rich Plasma; PRGF= Pletelet-Rich in in Growth Factors.*

**Table VI.**

| | *RCT* | *CT* | *SR* | *PS* | *LS* | *RS* | *CS* | *CR* | *Total* | *Dis-card* | *Total useful* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Laser and/or low-laser therapy* | 0 | 0 | 7 | 1 | 4 | 2 | 4 | 5 | 58 | 35 | 23 |
| *Teriparatide* | 0 | 1 | 9 | 1 | 1 | 1 | 0 | 9 | 23 | 1 | 22 |
| *APCs* | 1 | 5 | 4 | 1 | 1 | 1 | 2 | 5 | 21 | 1 | 20 |
| *HBO* | 0 | 2 | 10 | 0 | 0 | 0 | 1 | 0 | 14 | 1 | 13 |
| *Ozone therapy* | 1 | 0 | 3 | 0 | 2 | 1 | 3 | 2 | 13 | 1 | 12 |
| *Pentoxifylline/Tocopherol* | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 6 | 1 | 5 |
| *AF-GBS/TF-GBS* | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 4 | 0 | 4 |
| *FDG-PET* | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 34 | 31 | 3 |
| ***Summary*** | **2** | **9** | **36** | **3** | **8** | **9** | **12** | **23** | **173** | **71** | **102** |

*RTC=Randomized Clinical Trial; CT=Clinical Trial; SR=Systematic Review; PS=Pilot Study; LS=Longitudinal Study; RS=Retrospective Study; CS=Case Series; CR=Case Report.*

Fluorescence-guided bone surgery, Tetracycline/ Fluorescence-guided bone surgery), Teriparatide, FDG-PET (Fluorodeoxyglucose Positron Emission Tomography) and the administration of Pentoxifylline/Tocopherol. The present study evidence that the most cited additional treatment in the literature is represented by the laser therapy, followed by administration of Teriparatide.

The reported clinical outcomes in BRONJ/ONJ/ MRONJ treatments with additional therapies have been shown promising if compared to conventional surgery alone. For example, Vescovi et al. highlighted as the use of laser devices in MRONJ surgery represents a valid therapeutic option and enables the minimally invasive treatment of the early stages of the disease (61). With limits of the eligible study number, the analysis showed how most of the authors pointed out how these additional therapies are not substitutes of existing procedures, but they might be considered as a fundamental pre and/or post-operative steps to improve clinical outcomes and patient's life quality. A wider number of further prospective and retrospective studies, with a larger patients' samples, are needed to confirm this statement to better define the clinical effect of adjunctive therapies in MRONJ.

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# The use of computer-guided flapless dental implant surgery (Nobel guide®) and immediate function to support a fixed full-arch prosthesis in fresh frozen homologous bone grafted patients: a retrospective cohort study with 5 to 8-year follow-up

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**The introduction of computer-assisted and guided surgery has radically improved the possibility of using all available bone for implant support, reducing the need for extensive grafting procedures and allowing for better implant placement and restoration. Moreover, fresh frozen homologous bone (FFB) grafts have shown good osteoconductive properties and biocompatibility with results comparable to autologous bone patients. The purpose of this retrospective cohort study was to evaluate the survival and the success rate of implants and related fixed full arch prosthesis at the 5 to 8 years follow-up when performed with immediate function using a flapless surgical procedure and computer-aided technology (NobelGuide®**, Nobel **Biocare®** AB, Goteborg, Sweden) in patients previously treated with FFB grafts; treated at **the University of Verona with the NobelGuide®** system from January 2007 to December 2012 with at least 5 years follow-up were reviewed. **Survival implants and survival prosthesis' percentage reached 95% in a 5 to 8-year period. This study indicates that patients previously augmented with FFB graft for maxillary or mandibular bone atrophy can be safely treated with implant supported prosthesis based on the NobelGuide®** protocol, with the aid of **computer-generated guide.**

The introduction of computer-assisted and guided surgery has radically improved the possibility of using all available bone for implant support, reducing the need of extensive grafting procedures and allowing for better implant placement and restoration, both in grafted and non-grafted sites (1). Indeed, now it is possible to make use of all the available osseous volume during the planning and the surgical phase. This approach allows an accurate placement of implants using a flapless technique under the guidance of a surgical template, generated from the preoperative virtual planning of the implant. In this way, precise implant installation is possible through a thick layer of soft tissues, having the drills and the implants guided by a computer-generated surgical guide.

The planning is also useful to avoid obstacles or structures in the reconstructed bone such as screws, osteotomy sites and discontinuity of bone segments (2). This technique has shown to be as successful as traditional implant surgery with flap access (3-5). Moreover, the beneficial effect of flapless surgery without exposure of the periosteum may minimize bone resorption (6-19).

However, a major prerequisite for a restoration driven implant surgery remains the availability of bone of adequate length and width, suitable for the proper placement of implants of sufficient length.

*Key words: computer-assisted surgery, fresh frozen homologous bone grafts, flapless surgical procedure, NobelGuide®*

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Physiological resorption of the alveolar processes of the maxillary bones can lead to insufficient bone volume, especially in patients who have been edentulous for a long period of time, making it virtually impossible to place implants (20). Several solutions have been proposed to obviate bone volume deficiency (2, 21-26). The endpoint of most of these techniques is the augmentation of available bone volume with onlay and inlay grafts (27-28).

Recently the use of fresh frozen homologous bone (FFB) grafts have shown good osteoconductive properties and biocompatibility with results comparable to those of autologous bone but with a reduced morbidity, lower surgical risk and shorter operative time (29) without modification of the traditional techniques (30-31). Histological studies have confirmed these results, showing the presence of new bone and osteoclast activity 4 months after grafting, with 80% mature bone observed after 12 months (32). FFB grafts resulted in volumes of bone similar to those obtained with autologous bone grafts, however the amount of residual bone particles seems to be greater, which may indicate a slower remodeling process (33).

FFB is a widely used substitute for autologous bone especially in large reconstructions when block grafts are indicated (34). The behavior of FFB when used in combination with computer guided implant surgery is still not well understood, as studies are absent in the literature. Due to the extended regenerations of the jaws FFB was the first choice and it was used even in the sites where it was not necessary to reduce the differences between the grafted sites. The purpose of this retrospective cohort study was to evaluate the survival and the success rate of implants and related fixed full arch prosthesis at the 5 to 8 year follow-up when performed with immediate function using a flapless surgical procedure and computer-aided technology (NobelGuide®, Nobel Biocare® AB, Goteborg, Sweden) in patients previously treated with FFB grafts.

## MATERIALS AND METHODS

Inclusion criteria: clinical charts of patients with edentulous arches treated at the University of Verona with the NobelGuide® system from January 2007 to December 2012 with at least 5 years follow-up were reviewed. Patients› medical history and clinical data were collected, together with panoramic radiographs and CT scans. The inclusion criteria used were the following: medical history negative for pathologies generally contraindicating implant surgery (35-38), initial edentulism and previous pre-prosthetic surgery with application of fresh frozen bone grafts to restore a sufficient bone volume for implant rehabilitation of the jaws (Fig. 1-3). In particular, pre-prosthetic surgical treatment should have been carried out by the following techniques: ridge preservation with filling of the extraction sockets with FFB bone chips (A) (39) posterior bilateral maxillary sinus augmentation with lateral window with bone chips (B) (40-42) together with anterior maxillary bone block veneer surrounded by bone chips (C) (43-44) Le Fort I osteotomy with inlay technique of Keller (D) (29). In addition, all implant/prosthetic treatment and follow-up should have been carried out according to the NobelGuide® protocol (1). All the surgeries were performed by the same operator.

Grafting material: the material used in the pre-prosthetic surgical treatment was FFB. The FFB, obtained from the Veneto Tissue Bank in Treviso (Italy), is a mineralized, non-irradiated and only disinfected, frozen homologous bone. The bone harvesting was obtained from the anterior and posterior iliac crest, in the first 12 hours after donor death. The bone was then disinfected, for at least 72 hours at -4°C, in a polychemotherapeutic solution. The sample was then subdivided into cortico-medullary blocks or morcellized, packed in double sterile casing, and frozen at -80°C (45). Surgical procedure: six months after FFB grafts, if plates or osteosynthesis screw were used, these were removed and a temporary total or partial removable acrylic resin prosthesis was made.

NobelGuide® procedure has been described previously for dentate and edentulous patients (46-50). Based on computer planning a fixed metal-acrylic resin complete denture was constructed prior to the implant surgery and was immediately adapted and inserted after surgery. The technician inserted several gutta-percha markers (Hygienic, Coltène/Whaledent Inc. Mahwah, NJ, USA) in small holes with the diameter of 1.5 mm made in the prosthesis, as indicated by the NobelGuide® protocol. The markers are necessary to the software (Procera® or NobelClinician®, Nobel Biocare® AB, Goteborg,

**Fig. 1.** *Initial frontal aspect view of a female patient treated with our surgical technique.*

**Fig. 2.** *Upper complete edentulism in the same patient.*

**Fig. 3.** *Lower detrimental oral condition in the same patient.*

Sweden) for coupling two CT scans: one of the patients and one of the prosthesis. Once the modifications on the denture were complete, it was possible to send the patient to a radiological centre where a double CT scan was carried out: one of the patients wearing the prosthesis/radiological guide, correctly inserted, and one of the prosthesis alone. After 3D reconstruction of the CT images in the software, the Procera® or NobelClinician® software allowed us to plan the implant virtually according to the desired prosthetic result (Fig. 4-5).

The surgical operations were performed under local-regional anesthesia. The implants used were Brånemark System MKIII® (MKIII), Brånemark System Groovy® (Groovy) e NobelSpeedy Groovy® (NobelSpeedy) (Nobel Biocare® AB, Goteborg, Sweden) with an oxidized surface (TiUnite®, Nobel Biocare® AB, Goteborg, Sweden). Once the template was stabilized using a surgical index and three anchor pins, the flapless implants were inserted, according to the drill sequence specific for the type of implant planned. The template was then removed and the correct position of the implants was checked and temporary abutments were screwed in place. The prosthodontist relined a prefabricated provisional fixed metal-acrylic complete denture, including the temporary abutments in the prosthesis with resin and made it functional by adjusting occlusal contacts. One gram of amoxicillin/clavulanate (GlaxoSmithKline plc., Brentford, Middlesex, United Kingdom) every twelve hours for 6 days was prescribed.

The patients were then dismissed. Sutures were removed after 15 days and the patients were given oral hygiene instructions. The main follow-up appointments were delivery of the final fixed prosthesis (6-12 months), professional oral hygiene every 6 months, and regular control once a year to maintain good oral health and monitor the absence of complications and compliance with oral hygiene instructions. A radiographic evaluation (orthopantomogram or periapical radiograph of the implants) was performed each year. Clinical assessment. Implant survival was considered if these conditions were satisfied (from Malò 2007 modified) (51):

1. Presence of the implant as planned in the NobelGuide® treatment plan after surgery and during follow-up.
2. Clinical stability of the implant in the surrounding peri-implant bone at follow-up (bridge removed and implants individually checked).
3. Satisfactory function without any discomfort to the patient at follow-up.
4. No suppuration or infection present at follow-up.
5. No radiolucent areas around the implants at follow-up.

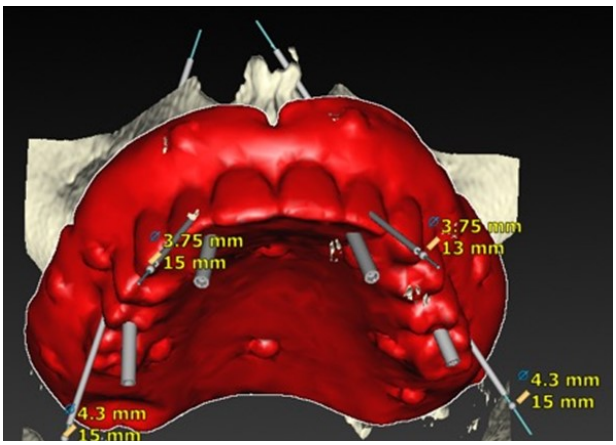



**Fig. 4.** *First screen shot from the digital planning with Nobel Guide Software.*

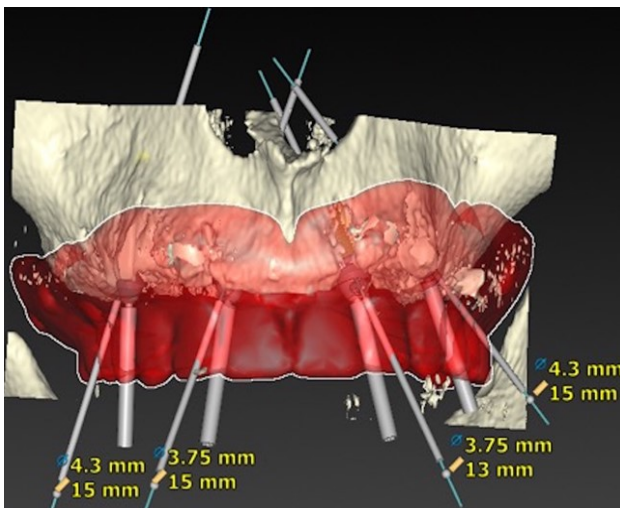



**Fig. 5.** *Second screen shot from the digital planning with Nobel Guide Software.*

Implant success defined in the scientific literature as the absence of infectious complications affecting peri-implant soft and hard tissues and the absence of more than 2 mm of peri-implant bone loss (PBL) (52-58) was considered. It was also recorded implants Pocket Probing Depth (PPD), soft tissue dehiscence, Mombelli Plaque Index (mPI) and the Mucosal Plaque Score (59-61). Survival of the prosthesis was considered if all these conditions were met immediately after surgery and during the follow-up:

1. Presence in the mouth of the original prosthesis (in-situ criterion) (62).
2. Presence of at least all the anterior teeth (for aesthetics) and two posterior occlusal units (premolar/molar) for function (59) as planned in the NobelGuide® treatment plan. Clinical assessments were performed from two calibrated operators.

Statistical analysis: the nominal and ordinal variables were tested with Fisher's Exact Test to evaluate association of implant failures due to diabetes or smoking. Peri implants parameter variables clinically and radiologically recorded were described using an Average and Standard Deviation. Bone loss Level (PBL) analysis was performed using Spearman rank to evaluate correlation between keratinized tissue width (67) and bone loss.

The Kruskal–Wallis Test was used to evaluate if the bone loss amount was correlated to the graft type or implants type. The Wilcoxon Mann-Whitney Test was used to evaluate the different bone loss amount surrounding tilted implants or straight ones. We decided to use non parameters Test because PBL variable resulted asymmetrically distributed; moreover the Shapiro-France tests and Shapiro-Wilk are highly significant ($p < 0.001$), suggesting a marked deviation from normality, and also was found a certain instability of variance between the groups in the study.

A possible correlation between keratinized mucosa width and plaque index, bleeding index and probing depth values was made using the Spearman test. The Wilcoxon-Mann-Whitney test was used to highlight differences between the maxillary torque and mandibular torque and maxillary and mandibular bone loss level. The significance for all tests was set at a p-value less than 0.05 ($\alpha$=5%).

## RESULTS

Characterization of the population: a total of 45 patients met the criteria of inclusion, receiving a total of 239 implants. NobelSpeedy was inserted significantly more in the maxilla compared to MK III and Groovy ($p<0.001$). The patients' follow-up ranged from 5 to 8 years (mean 69 months). (Fig. 6-8) The median age was 64 (interquartile range: 59-69) years (minimum 43, maximum 78 years), 9 patients were male (20%) and received 35 implants, 36 were females (80%) and received 204 implants. The median number of implants per prosthesis was 4 (range 4-6). A total of 54 full arch prosthesis were made, 34 in the maxilla and 20 in the mandible. Three patients (6.7%) were smokers (considered as

current exposure to smoking at intake) and received a total of 17 implants.

Implant survival: at 5 years was 94.6%. During the 5 to 8-year follow-up 13 failures (5.4%) were detected. Eight failures happened in the first year after NobelGuide® surgery. Seven patients (15.5%) had at least one failure. One patient had 5 failures. The patient with 5 failures was a heavy smoker of up to 60 cigarettes a day treated with ridge preservation (A) but the failure was immediate due to fracture of the complete maxilla during implant placement which precluded the possibility to proceed with the NobelGuide® protocol: the implants had to be removed and the maxilla stabilized with osteosynthesis. Five of the failures were detected at implant placement, due to the fracture of jawbone during surgery, two were detected at 6 months, four at 60 months, and one at 72 months. The low number of failures precluded a detailed analysis of risk factors.

**Fig. 6.** *Final frontal view after double full arch fixed implants prosthetic restoration.*

**Fig. 7.** *Upper view at 5 years follow up.*

**Fig. 8.** *Mandibular aspect at 5 years follow*

Failures tended to be more frequent in the maxilla (3.3%) than in the mandible (2.1%), but the difference did not reach statistical significance (p=0.35). However, data showed that failures occurred more frequently in implants placed in smokers than non-smokers (p = 0.010, Odds ratio 12.7). Five implants (29.4%) of 17 in smokers (28.5%) failed. Only 8 fixtures out of 222 (3.6%) in non-smokers failed. Implants placed as the distal abutment of the prosthesis were more likely to fail (p=0.04, Odds ratio 3.8). Torque level at implant placement was not related to implant failure (p=0.08).

*Implant success*

At the 5-8 year follow up was 85%. Two hundred three implants out of 239 reach success. The mean PBL was 1.86 (dev. St. ± 1.24 range 1.55-2.3). Bone resorption was considerably higher ($p<0.001$) in the maxilla. PBL was significantly influenced by different grafting procedures ($p<0.01$), and by different type of fixture ($p<0.01$) (Fig. 9).

*Soft tissues*

The mean PPD was 2.12mm (dev. St.±1.04 range 1-6). The mean mPI was 0.74 (dev. St.±0.74 range 0-3). The mean mBI was 0.43 (dev. St.±0.55 range 0-2). The mean soft tissue dehiscence around fixtures was 0.35mm (dev. St.±0.86 range 0-5). The average MPS was 1.15 (dev. St.±0.38 range 0-3). The mean width of KT was 1.23mm (dev. St.±1.05 range 0-4) but did not present a significative correlation with mBI, mPI, MPS ($p >0.01$).

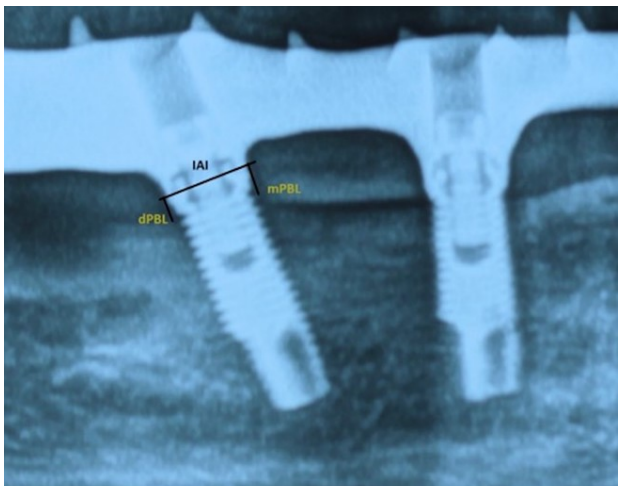



**Fig. 9.** *An example of radiological follow-up with periodontal parameters evaluation such as Perimplant Bone Loss.*

*Prosthesis survival*

One out of 20 (5%) mandibular full arch fixed metal-acrylic prosthesis failed during the follow-up. Otherwise in the 34 maxillary full arch fixed prosthesis there was not failures. As for implant failure, the low number of prosthetic failures precluded a detailed analysis of risk factors.

*Miscellaneous complications*

One patient experienced a fracture of the surgical stent in the mandible which was repaired during the surgery. The position of 2 implants in another patient was slightly aberrant from the planned position, resulting in a minor vestibular bone dehiscence at implant placement. The complication did not preclude achievement of sufficient torque, implant integration and a favorable emergence profile for the final prosthesis.

One patient had the fracture of maxillary bone during implant surgery. There was the failure of five implants also, which had been removed and after a 6 month rigid fixation, it was possible to go on with the procedure and deliver a fixed prosthesis to the patient. In the other patients, who had the failure of a single implant, it was possible to maintain the fixed restoration removing the failed implant and inserting another one. There was one prosthetic failure in one patient, who did not accept the restoration. In one patient there was the fracture of a resin tooth of the prosthesis. Three implants (1%) had a positive diagnosis for periimplantitis. A total of 13 implants failed (5%). Table I, Table II, Table III, Table IV and Table V.

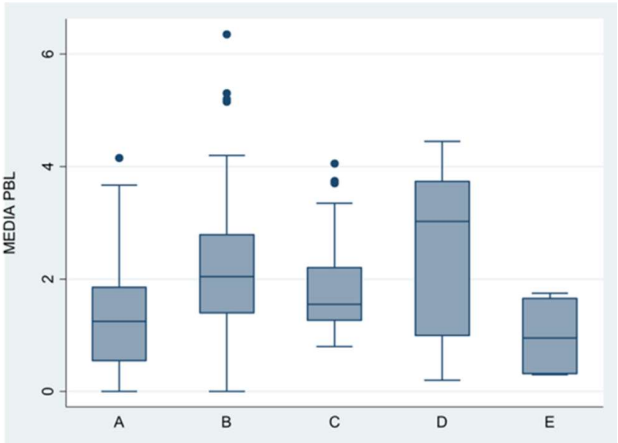
## DISCUSSION

The cumulative survival rate was 95%. Implant success rate was 85%, 20 implants (8%) did not show signs of inflammation or suppuration but had a PBL value higher than those reported in the success criteria also those were not classified successful. Three implants (1%) had a positive diagnosis for periimplantitis. During the 5 to 8-year follow-up 13 failures (5%) were detected. The low number of failures precluded a detailed analysis of risk factors. Failures had a tendency to be more frequent in the maxilla (3.3%) than in the mandible (2.1%), 8 failures in the maxilla happened in the first years after NobelGuide® surgery, while 5 failures in the mandible happened 4 at 5 years and 1 after 6 years (1). During the follow-up, implants placed in smokers were more likely to fail than implants placed in non-smokers (28.5% vs 3.6%). The lower survival rate of implants placed in smokers has been well documented in the literature (62).

**Table I.** *Survival and Success rate.*

| ***TOTAL IMPLANTS*** | ***239*** | ***100%*** |
|---|---|---|
| *Failed* | 13 | 5% |
| *Survived* | 226 | 95% |
| *Perimplantitis* | 3 | 1% |
| *PBL> success criteria* | 20 | 8% |
| *Success* | 203 | 85% |

**Table II.** *Perimplant Bone Loss.*




In our study survival of implants placed in reconstructed bone with FFB was comparable to those obtained with autologous bone grafts (64), FFB grafts (65) and NobelGuide® treatment on native (1), or fibula reconstructed bone (66). In fact, it has been shown that the use of various dentoalveolar bone grafting procedures to reconstruct deficient implant recipient sites are not an independent risk factor for implant failure (68). Peri-implant soft tissues had been investigated, particularly mBI, mPI and MPS are index to identify different degrees of soft tissue inflammation and condition allowing the clinician to evaluate the need of additional treatments. The values of these index showed an average good condition of soft tissues around implants, which is fundamental for the long-term maintenance of full arch prosthesis implant supported. Peri-implant Bone Loss was evaluated at 1 year and at 5 years after implants load. At 1 year the average PBL values were of 0.66±0.65mm while at follow up of 1.86±1.24mm, these data agree with success criteria (51). Bone resorption resulted higher in the upper jaw (58), this is due to the lower quality and minor density of the of maxillary bone. In literature it is even reported a higher risk of failure of implants positioned in the maxilla (69-73).

In this study, it has also been evaluated the Keratinized Tissue (KT) width around dental implants, as a matter of fact this is a variable of emergent interest in implant therapy. In literature there are discordant results about the possible relations between KT and implant health, in our study there was not a significative relationship between Keratinized tissue width surrounding implants and

**Table III.** *Perimplant Bone Loss.*

| GRAFTS | MEAN | SD | MIN | MAX |
|---|---|---|---|---|
| *A* | 1.36 | 1.11 | 0 | 4.15 |
| *B* | 2.26 | 1.35 | 0 | 6.35 |
| *C* | 1.89 | 0.86 | 0.8 | 4.05 |
| *D* | 2.48 | 1.54 | 0.2 | 4.45 |
| *E* | 0.99 | 0.78 | 0.3 | 1.75 |

**Table IV.** *Keratinized Tissue.*

| PPD | Media ± DS (mm) | Range interqu. | MIN | MAX |
|---|---|---|---|---|
| Mesial | 2.12±1.04 | 2-3 | 1 | 6 |
| Vestibular | 1.80±0.93 | 2-2 | 1 | 7 |
| Distal | 2.18±1.03 | 2-3 | 1 | 6 |
| Pal/ling | 1.85±0.87 | 2-2 | 1 | 6 |

**Table V.** *mPI and MPS.*

| Recession | (mm) | Range interqu. | MIN | MAX |
|---|---|---|---|---|
| Vestibular | 0.35±0.86 | 0-0 | 0 | 5 |
| Pal/ling | 0.36±0.28 | 0-0 | 0 | 3 |

**Table VI.** *mPI and MPS.*

| | Media ± DS | Range interqu. | MIN | MAX |
|---|---|---|---|---|
| mPI | 0.74±0.74 | 1-1 | 0 | 3 |
| MPS | 1.15±0.38 | 1-1 | 0 | 3 |

PBL. Implant position did not condition significantly PBL, particularly tilted implants compared to straight did not showed a meaningful major PBL (74-75).

The type of implant and the different grafting procedure influenced significantly bone resorption. Speedy Groovy manifested a higher resorption but this data must be argued because those implants had been used mainly in the maxilla. MK III Groovy showed a lower bone resorption than Speedy Groovy and MK III. The grafting procedures with a significantly greater PBL were sinus lift and Le Fort I inlay still for the same reason of lower quality of maxillary bone. Initial torque level at implant placement was not related to implant failure. Furthermore, torque level may not be a proper measurement of implant primary stability.

In one patient 5 implants failed because of fracture of the basal bone at implant placement. The reason for this is still unclear but it may have speculated that the presence of a surgical stent in an atrophic maxilla may transfer the stress exerted by the implants on basal bone. This, together with the fact that no fracture of grafted bone surrounding the implant occurred in our patients, may indicate that complex implant/surrounding bone is safely stabilized by the stent, but the resulting stress may be exerted outside the ferrule of the stent. One patient experienced a fracture of the surgical stent in the mandible which was repaired during the surgery. Fracture of the surgical stent has already been described as a possible complication which can be related to insufficient thickness or imperfect fitting of the stent in relation to the amount of stress generated by implant insertion (76). In another patient the position of 2 implants deviated slightly from the planned position. This complication did not preclude achievement of sufficient torque, implant integration and a favorable emergence profile for the final prosthesis.

An individual error can occur at each step of the guided surgery protocol, starting from the radiographic guide to the placement of the implant leading to incorrect implant placement (9,77-78). Particularly stereolithographic surgical guide stents have the potential to be dissimilar from the original scan denture. The ISO threshold setting in the conversion software is a very sensitive component of the production process (79-81). The only prosthetic failure occurred in one patient who did not accept the restoration, also it was removed and substituted with a mobile device. In one patient there was the fracture of a resin tooth of the full arch fixed prosthesis, hence the prosthesis was repaired through the substitution of the broken tooth. Based on the results of our retrospective study, we can conclude that:

1. Survival of implants was high, reaching 95% in a 5 to 8-year period.
2. Survival of the prosthesis was high reaching 95%

in a 5 to 8-year period.
3. Factors significantly related to failure of the implants were smoking.
4. Factors significantly related to PBL were implant position (maxillary or mandibular), type of implant and graft procedure.
5. A higher torque level at implant insertion did not correspond to a lower risk of implant failure.

This study indicates that patients previously augmented with FFB graft for maxillary or mandibular bone atrophy can be safely treated with implant supported prosthesis based on the NobelGuide® protocol, with the aid of computer-generated guide. This procedure may be a promising treatment option, offering several advantages to both clinicians and patients, while keeping the same degree of predictability in terms of torque levels, survival and success of the implants and the prosthesis compared with conventional treatment. However, in our study the low number of implants and prosthetic failures precluded a detailed analyses of risk factors associated to these failures. Before drawing any general conclusion, the benefit of the procedure should be further evaluated by prospective clinical trials where the possible endpoints of the treatment should be more thoroughly evaluated and compared with conventional protocols on the same study population.

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# Ketamine in dentistry: a useful way for non-compliant pediatric patients

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**The infant, like the young un-cooperative or odontophobic patient, constitute the most complex type of patient to be treated and it is frequent in modern society. The treatment of these patients is necessary to resolve the infectious-antalgic urgency and subsequently to build the patient/doctor relationship for continuing general dental care. Conscious sedation is the only way to approach this type of patient. Where therapeutic success with traditional sedation techniques is not achieved, as frequently happens in these patients, sedation with ketamine is the extreme ratio for the purpose of effective resolution of the dental problem, obviously carried out within facilities authorized for these anesthesiological modalities such as private outpatient surgery structures where, when necessary, it is possible to carry out the treatments also under general anesthesia as well as with ketamine.**

Today, despite the fact, that instructions for having good oral health appear traditionally rooted in everyone's life and that the latter are remembered daily through the media, dentistry is still faced with pathologies, even serious ones, in patients of pediatric age (1-3). From 1960 into the years of 2000, the development of the concept of prevention, the evolution of auxiliary technologies and the introduction of toothpaste pastes containing fluorine led to a reduction in the prevalence of carious disease in the population, especially among pediatric patients (4-6). Since the entry into the new millennium, however, the frenetic high speed social globalization without real integration and the establishment of a relative-individualistic culture society oriented to total liberalism have led to the reduction of knowledge and respect for the instructions necessary for maintaining a good oral health mentioned above (7, 8).

Specifically, first, the result of recent ethnic, economic and demographic changes has led to an average impoverished population, superficially educated and consequently apprehensive. Therefore, a worsening oral health conditions was generated, detected as the prevalence of carious pathology is greater in the population segment with reduced economic possibilities (5, 7, 8). Furthermore, secondly, the huge educational differences on an ethnic basis, the lowering of the demographic rate and the exaggerated amount of information provided by the media unfiltered by educational "campaigns" led to a confused and anxious parenting class that transmits the fear of pain to children by generating a reduction in tolerance capacity, even if minimal (9).

The treatment of the pedodontic patient, paradoxically, is therefore nowadays more difficult to deal with; even though the psychological approach techniques are well known (9). This category of patients, moreover, has often had negative experiences that may be due to an emergency intervention following a trauma or to some carelessness and/or

*Key words: Ketamine, anesthesia, odontophobic patient, patient/doctor relationship*

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lightness due to inexperience. These events generate a real phobia in the small patient, with a consequent refusal to dental care and a tendency to reject any general figure in medical field (3, 10-11). The phobic pedodontic patient (3, 10-11) is a type of patient with whom it now becomes necessary to relate and to be able to aid in case of:

- need to resolve acute pain symptoms;
- need to preserve or restore correct chewing function;
- need to preserve the deciduous teeth in order to reduce orthodontic problems (12-13) by obtaining a physiological exchange;
- need to restore social aesthetics (14-24).

The treatment in the cases mentioned above will be possible, only with the aid of sedation (25-27) on the infant patient as well as on the phobic pedodontic (3), caused by his lack of collaboration. In the same way, the natural maturation of the psychological profile should not be neglected but, in agreement with the parents, also possibly supported with the help of psychotherapy. In fact, the choice of sedation, with ketamine (28), born from the desire to be able to rebuild a relationship with the infant, preserving the integrity of his teeth from caries and his psyche from phobias. The progressive reduction of the use of the sedative aid until the complete elimination of it must be the goal reachable, at the same time as the growth of the patient's psychological profile, in order to avoid all possible side effects (25-29) linked to the execution of the procedure and to repetition of itself.

## MATERIALS AND METHODS

Ketamin. Backgrounds (29):

- in 1962 it was synthesized for the first time by Calvin Stevens;
- in 1963 it was patented;
- in 1965 it was defined by the term "dissociative anesthetic" by Edward Domino;
- in 1969, ketamine hydrochloride became available with a prescription under the name Ketalar®.

Pharmacological nods (30): sedation with ketamine is called "dissociative anesthesia" characterized by catatonia, amnesia and analgesia without real loss of consciousness. The drug is a chemically related ARY cyclohexylamine phencyclidine (PCP), a drug frequently used and abused for its psychoactive properties. The mechanism of action of ketamine can involve blocking the membrane effects of glutamic acid, an excitatory neurotransmitter, at the level of the NMDA receptor subtype (N-methyl-D-aspartate). Ketamine, a highly lipophilic drug, is rapidly distributed in highly vascularized organs, including the brain, and is subsequently redistributed in less perfused tissues, with simultaneous liver metabolism and both urinary and biliary excretion.

In addition to being a powerful analgesic, ketamine is the only intravenous anesthetic that usually produces cardiovascular stimulation. Heart rate, blood pressure and cardiac output have generally increased significantly. The peak of these effects occurs in 2-4 minutes after intravenous injection and the return to normal levels occurs in 10-20 minutes. Furthermore, ketamine produces cardiovascular stimulation by excitation of the central sympathetic nervous system, probably by inhibiting the reuptake of norepinephrine at the level of the sympathetic nerve endings. Increases to adrenaline and norepinephrine plasma levels occur as early as 2 minutes after intravenous administration of ketamine and return to normal levels after 15 minutes, significantly increasing brain blood flow, brain oxygen consumption and intracranial pressure.

Finally, in most patients, ketamine slightly decreases the respiratory rate for 2-3 minutes while allowing the maintenance of the muscular tone and the reflections of the upper airways. Although it is a desirable anesthetic, the use of ketamine is associated with disorientation, sensory and perceptual illusions and vivid dreams that follow anesthesia, effects that are called "emergence phenomena". Diazepam 0.2-0.3 mg / kg intravenously, 5 minutes before the administration of Ketamine, reduces the incidence of these phenomena.

Dissociative Sedation Technique with ketamine: the technique in question must be performed by an anesthesiologist in a protected environment (24, 28), as we usually carry out in our extra-hospital surgery facility, which has the appropriate authorization and organization to perform general anesthesia indeed. It is indicated in children up to about 6 years with a body weight of 25/30 kg in which milder techniques such as those that use nitrous oxide and/or benzodiazepines have failed. It initially involves an intramuscular injection of a single solution of ketamine 5mg/kg and midazolam 0.1mg/kg. Then the above injection generates the baby falling asleep

in 60-90 seconds and allows the intravenous infusion of ketamine 5mg/kg / h (Fig. 1).

Finally, the association of propofol 1-2mg /kg/h reduces the percentage of postoperative vomiting. The laryngo-pharyngeal reflexes of the infant remain intact, therefore even in the presence of liquids in the mouth, swallowing occurs physiologically, protecting the airways spontaneously. For greater safety, the child is positioned on his side and under constant aspiration of his physiological secretions (Fig. 2-3).

The sialorrhea produced would be antagonizable with atropine, which however is not administered because the vasoconstrictor is already present in local anesthetic and in ketamine therefore would result in a very constant high heart rate. We recommend 45/90 minutes as maximum intervention duration, thus generating an "anesthesiological tail" of approximately 90 minutes. The "anesthesiological tail" is proportional to the quantity of ketamine administered. Saturation and heart rate should be monitored until awakening (Fig. 4-5).

**Fig. 1**. *Vein cannulation.*

**Fig. 2**. *Lateral patient position to promote swallowing reflexes.*

**Fig. 3**. *Operator position based on the patient's mandatory position.*

In conclusion, a safety medication of betamethasone 1.5mg is administered intravenously. Respect for these indications allows the child to be released serene and without short-term memory. Upon awakening of the patient, parents should be informed that nystagmus, diplopia and vomiting can, although not frequently, be present and have no pathological significance by spontaneously regressing and that feeding can be quickly resumed even if with caution.

## RESULTS

Ketamine is an effective agent for conscious sedation in pediatric emergencies, with minimal adverse effects and sequelae compared to traditional agents such as benzodiazepines, opioids and hypnotic


**Fig. 4**. *Syringe pump for constant infusion.*

**Fig. 5**. *Parameter monitoring.*

sedatives. The choice, at the pediatric dental level, stems from the fact that today it is still the only inductor injectable by the intramuscular route and this makes it easier to administer in the infant patient as in the dental phobophobic patient (28). The importance of ketamine in pediatric dentistry is linked to the fact that it leads to relative cardiovascular stability and has limited effects on the respiratory system: in fact it maintains intact the laryngo-pharyngeal reflexes and therefore, even in the presence of liquids in the mouth, allows swallowing physiological by spontaneously protecting the airways (31).

In general, the above-mentioned pharmacological characteristics avoid hospitalization, prevent pain and reduce the discomfort for the pediatric patient while specifically allow to carry out any dental intervention also with the help of the rubber dam, since the infant manages physiologically to control salivary flow. In the post-operative course, the use of ketamine can lead to transient visual disturbances, nausea and vomiting, while side effects are frequent especially in psychiatric patients: realistic dreams, hallucinations, floating sensation, delirium, agitation, dysphoria. Prophylactically associated administration of benzodiazepines (Midazolam) reduces the mentioned phenomena ensuring post-operative retrograde amnesia, useful to reduce the discomfort of the pediatric patient (32).

## DISCUSSION

Summarizing, ketamine compared to other categories of drugs commonly used (33-36) determines dissociative sedation leading the patient to a catalytic state characterized by deep analgesia and amnesia with the maintenance of airway protection reflexes, spontaneous breathing, and cardiopulmonary stability. It is therefore excellent for sedation to perform short dental procedures, which would lead to negative pain and emotional aftermath in the pediatric dental phobia patient or in more invasive procedures (37-45). The resolution, through ketamine, of the dental infectious-antalgic urgency will allow the approach to the phobic pedodontic patient (28).

Subsequently, it will be possible to reconstruct the "patient/doctor" relationship, to completely overcome the phobia, through progressive pre-treatment psychological therapies and positive dental experiences gradually less supported by the sedative aid (46). In conclusion, ketamine is an effective agent for the conscious sedation of uncooperative pediatric patients and represents the last alternative to an intervention performed under general anesthesia. The comparison with other sedation techniques has no value, as the choice of ketamine must only take place when success has not been achieved through other modalities (33-36). Ketamine must be used by an anesthesiologist with experience in the pediatric field.

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# The rule of hydrogen peroxide long term rinse during a particular alveolar bone healing after ONJ injuries in a patient with periodontal disease: a 4-year radiological follow up report of a mental nerve emergence migration

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**Bisphosphonate Related Osteonecrosis of the Jaw (BRONJ) is a pathology initially described in the early 2000s that has become increasingly common in clinical dentistry and maxillofacial practice due to the frequent use of bisphosphonates medical drugs (BPs) to treat various diseases such as osteoporosis, Paget's syndrome, osteomyelitis and in bone metastases secondary to tumors. Supragingival irrigation applied as monotherapy and in combination with root planning or BFs related bone necrosectomy revealed that supragingival irrigation with a variety of agents reduced the gingival microbial load and gingival inflammation. In this 4-year follow-up study we analyze the use of hydrogen peroxide ($H_2O_2$) as an antimicrobial agent for maintenance periodontal health, improving the longevity of teeth and oral cavity healing process.**

Since its first description in 2003, reports of bisphosphonate related osteonecrosis of the jaw (BP-ONJ) have been accumulated. With the ability to reduce bone turnover through selective inhibition of osteoclasts, Bisphosphonates have been used widespread in treatment of osteoporosis and bony metastases of malignant diseases. They are administered orally or intravenously, whereat the bioavailability of oral bisphosphonates is below 1 % (1).

Due to local factors like chewing forces, oral bacteria, the periodontal gap and a thin mucosa, the alveolar bone necessitates an elevated osteoclast-dependent bone turnover to maintain integrity (2). When osteoclasts are diminished by a high local concentration of BPs, the bone is not capable to react to these local factors what may end in necrosis (3). Few bacterial lines are the co-factors in formation of gingival-periodontal diseases (4-10) as well as chronic bone infection (osteomyelitis) that could conduct as an open exposition of ill bone into the oral cavity.

Fortunately, some studies have shown the effectiveness of supragingival irrigation applied as monotherapy and in combination with root planning or BFs related bone necrosectomy revealed that supragingival irrigation with a variety of agents reduced the gingival microbial load and gingival inflammation, and as a method of maintenance periodontal therapy, it plays an important role in the longevity of teeth or oral cavity healing process (11). This further emphasizes the importance of supragingival irrigation in the treatment of periodontal disease. Hydrogen peroxide ($H_2O_2$) has a long history of use as an effective antimicrobial agent with a broad spectrum of activity, including activity against bacterial spores and viruses (12)

*Key words: Bisphosphonate, jaw osteonecrosis, hydrogen peroxide, supragingival irrigation, gingival inflammation*

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and is extensively used in applications where its decomposition into non-toxic byproducts (water and oxygen) is important (13).

The aim of this case report was to underline the efficacy of long-term weekly supragingival irrigations with aerosolized 0.5% H2O2 as maintenance therapy after bone necrosectomy due to BFs administration: its properties had been effective on clinical parameters and on morphological changes in bone tissues healing as this radiological CBCT 4 year follow up revealed.

## MATERIALS AND METHODS

An 82-year-old woman returned to our observation clinic after ten years from the last check-up. She only underwent restorative treatments and full mouth hygiene. The previous dental cemented prosthetic rehabilitation did not show any radiological and clinical sign or symptom of endodontic periapical disease. She only referred a slight pain in the right hemi mandibular region: a red mucosal inflammation area was visible surrounding lower right canine and I premolar teeth. There was no bone exposure or mucosal ulceration. Unfortunately, radiologic exam revealed a large radiolucent area corresponding to bone resorption. The area involved was 13mm long and 10 mm high. An OPT confirmed this radiolucent issue and it appeared worse because of its further posterior extension.

The medical history excluded any oncological impairment as a secondary oncological injury. So, it appeared quite clear it was a BRONJ case. In fact, drug history revealed assumption of Alendronate, (ADROVANCE 70 mg one pill every week for 4 years). We considered mandatory an antibiotics prescription (amoxicillin + acid clavulanic 1 g pills every 8 hours for 6 days).

Inexplicably the patient had been denied checkups for six months. After this period, the clinical situation had decidedly got worse. In fact, she referred increased pain, swelling and slight paresthesia. The oral inspection showed an ulcerated mucosal area surrounding 44 teeth. The underlying tissue appeared had a grey necrotic aspect. The radiological exam and OPT confirmed a bigger radiolucent lesion in apical direction involving the mental foramen. The successive CBCT exam showed effective extension of the radiolucent lesion as it was visible in CBCT section 28, 32 and 41. On the 30th of March 2012, the patient was sent to the Rovigo "Santa Maria della Misericordia" Hospital for a surgical debridement toilet. The subsequent histological examination gave the following result: 'Necrotic bone fragments included in purulent-fibrin material incorporate bacterial colonies morphologically consistent with Actinomyces.

For 4 full years, from April 2012 to April 2016, the patient was kept under periodical close medical observation in a private dentist clinic in Legnago (Verona, Italy). Twice a week she underwent careful monitoring of wound healing in concomitance with hydrogen peroxide washing of the affected area. During this period, radiological examinations (CT-Cone Beam and OPT) were carried out at regular intervals to monitor the process and the quality of healing. Four clinical indices of periodontal inflammation have been collected since April 2012: approximal plaque index (API), modified gingival index (MGI), bleeding index (BI), and pocket probing depth (PPD). The patient had shown a substantial clinical improvement during Hydrogen peroxide irrigations.

## RESULTS

We note that Treatment suggestions of manifest BP-ONJ differ. Some authors agree with surgical approach and refer mucosal healing and wound healing after necrosectomy ranging 84 to 100% (14-16). Healing of the necrosis occurs in only 25% after strictly conservative measures and 28-58% after partial resections or debridement without soft tissue closure (17-18). However, in 2014 update the AAOMS still recommends management with antibacterial mouth rinses and antibiotics in most of the cases to preserve the quality of life (19). Others suggest more invasive surgeries for an implant/prosthesis rehabilitation (20-40) and for restoring sufficient quantities of soft tissues (41-47).

Among all the commercially available antibacterial chemical compounds the peroxide hydrogen appears to be very effective. Its oxidative properties hinder the spread of certain specific bacterial lines in periodontal pockets (especially the red complex of Socransky) which negatively affect an already compromised area (48). Among the first bacterial colonizers of the dental surface and of the

periodontal pockets we find the Actinmyces Spp. (mostly obligate anaerobes) (49) that with other periodontal pathogen families (yellow, green and purple Socransky complex) are the conditions for the subsequent growth and multiplication of the main etiological agents of periodontal disease (50) which is the Socransky's red complex (51).

The red cluster is composed by Treponema Denticola, Tannarella Fonsythus and Porphyromos Gingivalis, this last one is often associated with periodontal bone loss and is microbiologically considered one of a handful of pathogens that cause chronic periodontitis (52). The most common species find on the surface of osteonecrosis area are Staphylococcus Aureus, Streptococcus Aureaus (part of yellow Socransky complex) and gram-negative Fusobacteium (orange Socransky complex) (49, 53). To oppose the pathogenic action of P. Gingivalis and F. Nucleatus different medical drugs have been utilized.

Few scientific articles reports the use of hydrogen peroxide help to obtain a significant reduction of in vitro growth of P. Gingivalis (54), *in vivo* reducing periodontal inflammation as an antibacterial minimally invasive additional treatment of periodontal pathology (55) or moreover, used as a long term adjunct mouthwash to daily oral hygiene for reducing the early sings of gingival redness (56) and last in dentifrices containing 0.5% SCN- and 0.1% H2O2 inhibited plaque and decreased gingivitis (57). Moreover, peroxide hydrogen is extremely useful on obligate anaerobes such as few species of Actinomyces Spp. isolated in the bone surface by the histological post-surgery exam in this report. In this context a combined approach (surgical debridement and hydrogen peroxide) resulted to be successful and strictly indicated. Specifically, the long-term rinse.

Through an objective and intersubjective analysis of radiological data in our hands (CT and OPG) we measured at different times (from September 2011 to April 2016) the bone volume between 43-47 in bucco lingual frontal prospective and in apical-coronal sagittal prospective. These measurements are expressed in millimeters. Comparing specific radiological cuts in the equal points it appears a general increase in bone volume. It can also be noted a peculiar coronal migration of mental nerve's emergency which indicates not only a regression of the initial minus of lesion, but even a further bone centripetal apposition (Fig.1-3).

Histologically it has also been demonstrated that high concentration of hydrogen peroxide affects the wound healing process of tissues through proliferation and differentiation of fibroblast (58), the promotion of myofibroblast differentiation from fibroblast (59) and increases osteoblast survival by decreasing oxidative stress (60). Our case report seems to confirm radiologically these histological healing processes. The centripetal bone healing apposition had been progressed for 4 years as the CBCT screen shots sequence showed alongside the hydrogen peroxide long term rinse.

## DISCUSSION

The idea arises from the considerations listed above is a complementary treatment of BP-ONJ with a surgical courettage/removal of osteonecrotic

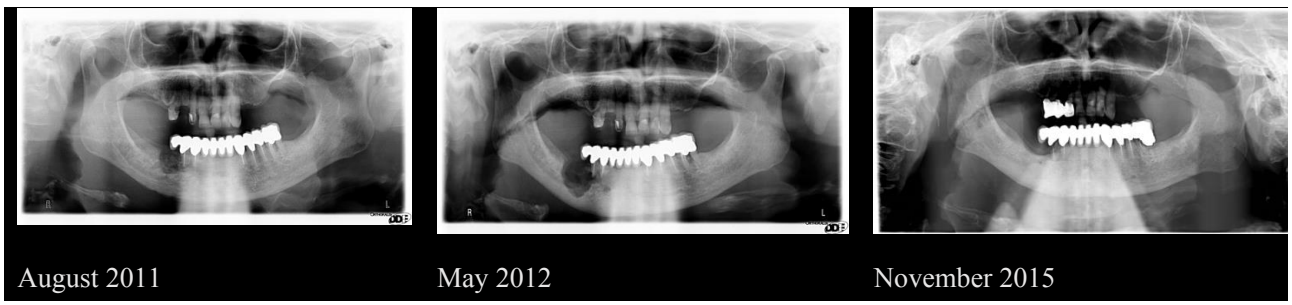


**Fig. 1.** *Orthopantomography*

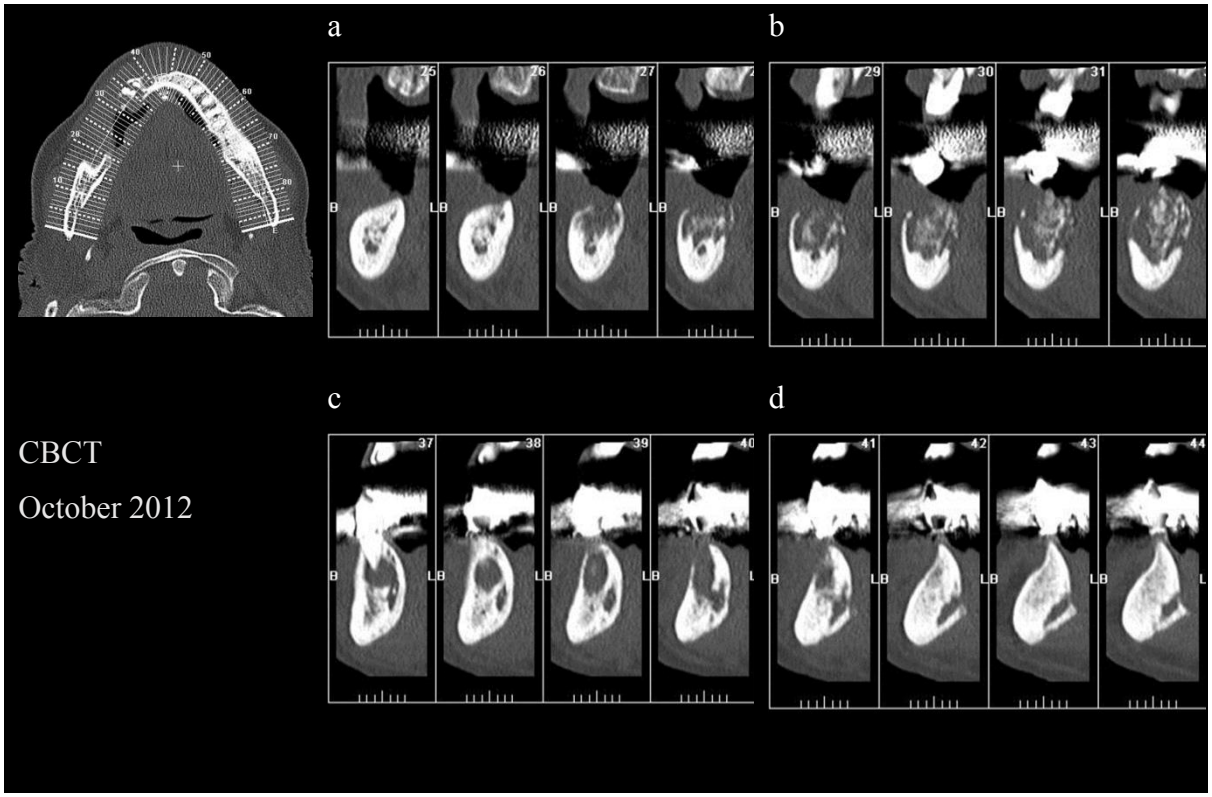


**Fig. 2.** *Cone Beam Computer Tomography. Upper line;* **a***): molar area;* **b***): premolar area. Bottom line;* **c/d**): *metal foramen.*

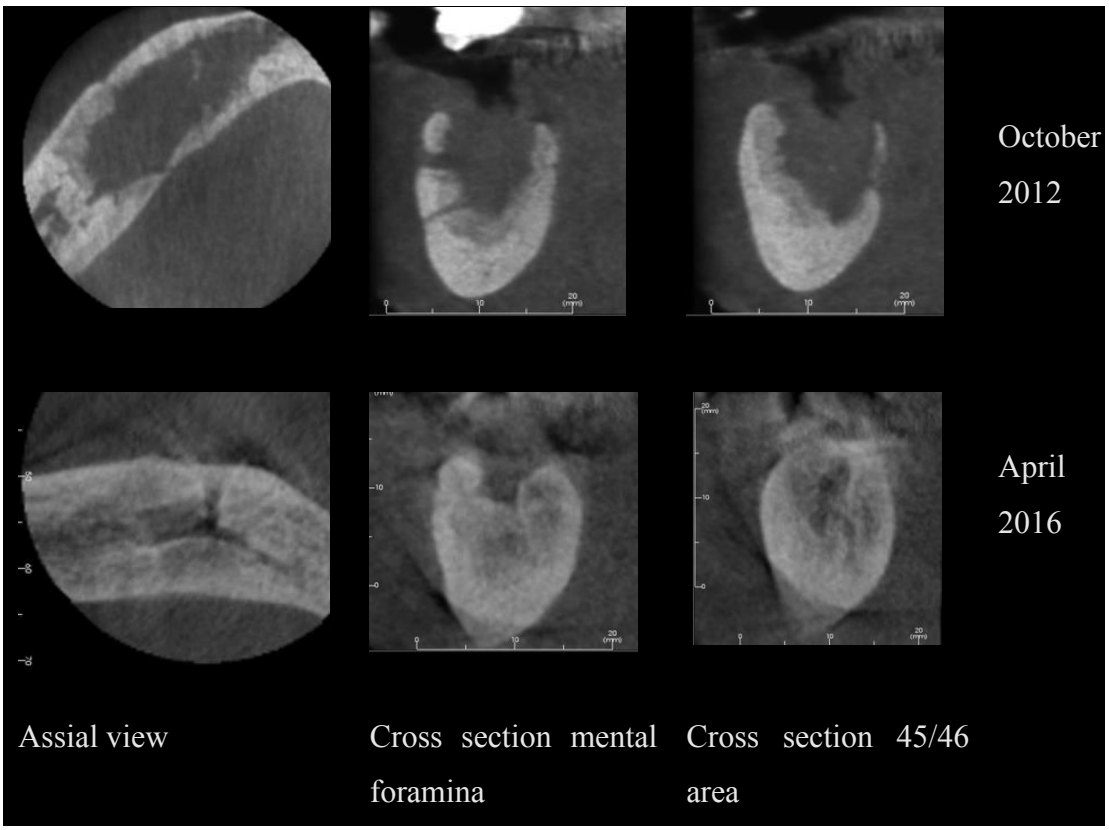


**Fig. 3.** *Assial view*

areas and frequent washes with hydrogen peroxide. Encouraging data on the hypothetical success of this therapy comes from this clinical and 5 years long CBCT radiological follow up that describes a singular bone healing appreciable by a coronollization of mental foramen. The present study shows that non-surgical treatment with long term maintenance therapy (twice a week supragingival irrigations with Hydrogen peroxide for 4 years) improved clinical periodontal status and bone healing process. However, these findings need to be confirmed in larger and more controlled studies for any observation regarding the potential benefits of this therapy. Moreover, we found a correspondence between radiological images of bone healing and the long-term use of supragingival hydrogen peroxide rinse in the same period of follow up.

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# Laser lingual frenectomy: basal eutonia achievement by natural homeostatis

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**The aim of present study is a macro evaluation of adjustment to allow homeostasis before and after frenectomy. Macro analysis was done on 7 pediatric patients tested firstly simple surface elettromyography (EMG) to evaluate masticatory muscles, secondly the Romberg's test to assess the posture and thirdly cephalometric analysis according to Giannì and Rocabado to assess orthodontic variations. The frenectomy was performed with diode laser (wavelength 890 nm). Pre-frenectomy EMG outcomes indicate a clear masticatory muscular imbalance with a different electrical activity compared to physiological standard values and functional basal balance. Results after frenectomy EMG show a normalization of basal values with an improvement of mandibular posture. Depending on cephalometric analysis, outcomes reveal a tendency to normalize the cervical lordosis, previously altered. Ultimately, pre-frenectomy Romberg's test shows initial instability in the static posture, which decreases after frenectomy. In conclusion, the short lingual fraenum not only has static correlations with the oral cavity but also dynamic connections with the cervical posture and muscular basal organization. So, homeostasis includes macro alterations involving muscular tone and bone position. Frenectomy could favor the restoration of the basal eutonia achieved by a natural homeostasis.**

The lingual frenum is a mucous-fibrous band which fixes the tongue to oral cavity floor (1-10). Usually lingual frenum insertion undergoes a physiological progressive atrophy from birth to the end of youth (11-19). Lingual frenum is called short when that atrophic process does not happen. It results hypertrophic limiting swallowing, speech, chewing and oral hygiene (20-43). The worst condition is ankyloglossia, also known as tongue-tie. In this case tongue results totally locked to oral cavity floor restricting movement (Fig. 1).

Then advancement of knowledge in each field of dentistry (1-5) is the fundamental aim of every research starting from a particular idea: the purpose of the present study is the evaluation of relationship between lingual short frenum, joide bone and cervical posture before and after frenulectomy in short lingual frenum patients. Furthermore, this analysis is completed by masticatory muscle tone investigation before and after frenulectomy.

## MATERIALS AND METHODS

Seven patients, 2 9-year-old girls and 5 boys of 7-, 8-, 10-, 11- and 14-years-old (AA, GM, CS, DRA, TS, LR, SD) were treated in the Orthodontics Department of the Padua University Clinic. Each of them was diagnosed with a short lingual frenulum and in one case ankyloglossia. The inclusion criteria in the study were the short lingual frenulum, good physical health, absence of neck and

*Key words: laser, lingual frenum, eutonia*

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lumbar pain, absence of midline asymmetries and absence of pathologies on the spine. Specifically, the diagnosis of short frenulum was made by measuring with a millimeter gauge, using the reference intervals of the classifications of Kotlow (44-45) (tip distance of the tongue, lingual insertion of the frenulum) and Ruffoli (46) (total length of the frenulum) (Table I, II).

A functional evaluation was performed (lingual protrusion movements, raising towards the palate, retrusion, analysis of swallowing and lingual phonator movements) (47-48). For each patient, a macro evaluation was carried out on a case-by-case basis (49). Before the frenectomy, each individual underwent surface electromyography (sEMG), performed with a computerized system connected to surface electrodes (Fig. 2) (50-54) and body and static postural evaluation (Fig. 3) that dynamic (55-64). The detection of muscle activity focused on the anterior masseter and temporal muscles: respectively at rest for the measurement of muscle tone and dynamics during the natural frame alternating with the frame suspended on cotton rollers. The postural analysis, however, was carried out on the sagittal and frontal plane with the aid of a millimeter stick, a reference to indicate the physiological midline. The positions taken by the various patients on the two floors were photographed with a digital camera. Finally, the static postural balance was tested by Romberg's postural test.

A cephalometric study of the pre-frenectomy teleradiographs in a latero-lateral position of the various patients was subsequently performed in a standardized manner, i.e. positioning each patient on a craniostat with the Camper plane parallel to the floor. The cephalometry according to Giannì (65-66) and Rocabado (67-74) was performed through a computerized program (29); the first was used for the study of the classical parameters, the second, however, for the greater attention to the occipito-cervical and mandibular-hyoid-cervical relations.

Specifically, the first relationship mentioned above was

**Table I**. *Kotlow's classification.*

| Kotlow's classification | Range (mm) | Status |
|---|---|---|
| physiological | >16 | acceptable |
| I | 12 - 15 | medium |
| II | 8 - 11 | moderate |
| III | 3 - 7 | severe |
| IV | <3 | ankyloglossia |

**Table II**. *Ruffoli's classification.*

| Ruffoli's classification | range (cm) |
|---|---|
| Normal | ≥2 |
| Medium | 1,6 - 1,9 |
| Moderate | 0,8 - 1,5 |
| Severe | ≤0,7 |

studied by means of the cranial cervical angle (106±5°) formed by the union of the McGregor plane with the plane passing between the odontoid and the epistrum in the lower anterus point and the lordosis angle (5°±2°) formed by the plane passing between the inferior posterior and super posterior points of the odontoid (OPT) and the plane passing between the inferior posterior points of the body of C4 and the posterior inferior of the odontoid (CVT).

**Fig. 1**. *Lingual frenum.*

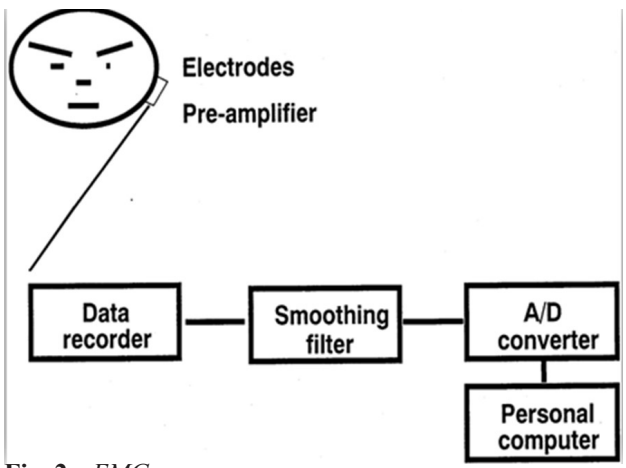



**Fig. 2**. *sEMG.*

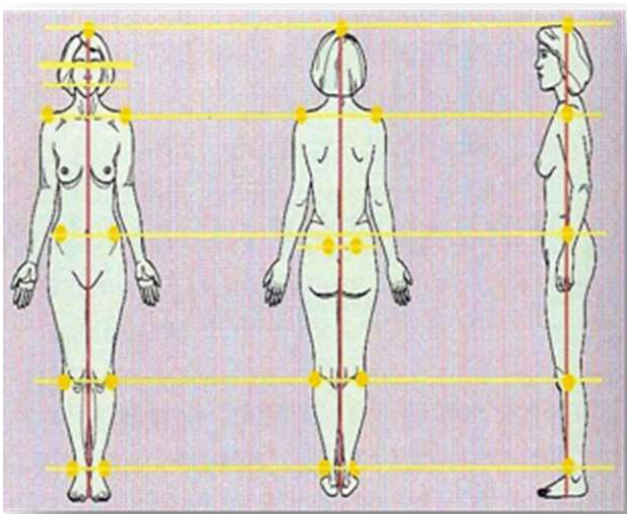


**Fig. 3**. *Static postural analysis.*

The second ratio was analyzed by means of the hyoid triangle (from 0 to 4 mm) formed by the base plane joining the retrognation point rGn, the most anterior lower point of the body of C3 and the sides that from these two points reach the vertex point of the body of the hyoid bone located anteriorly. The set of measurements made it possible to have a complete picture of the skeletal situation. The morphology of the cervical vertebrae according to the Bacetti, Franchi and McNamara method for the evaluation of the biological age of each patient was also evaluated on teleradiography (Fig. 4) (75-79).

The extensive evaluation was followed by the section of the frenulum in the oral surgery department of the University hospital of Padua. Prior to the start of the surgery, a topical anesthesia with Lidocaine cream associated with prilocaine 2.5% and infiltration anesthesia with 0.8 mL of mepivacaine without vasoconstrictor was performed (80-86). The frenulum was cut with diode lasers with a wavelength of 890 nm and 3W of power (87-90). Following the intervention, parents were given indications for lingual exercises to make the tongue move in the months following the operation, avoiding unpleasant relapses (91-97).

In addition, 2 checks were performed 1 week and 1 month after the frenectomy. In these visits, measurements using the frenulum caliber were carried out in relation to the diagnostic classifications (98-100), the SEMGG and the postural evaluation associated with the Romberg test. In conclusion, another cephalometric study was performed with the means and criteria mentioned above on standardized teleradiographs performed after surgery.

## RESULTS

The frenectomy immediately benefited the patients by allowing the movement of the tongue in previously unattainable physiological positions. So, actions such as swallowing, pronunciation and lingual protrusion, previously atypical and deficient, have undergone a marked improvement towards physiological parameters. In fact, post-surgery

measurements of the frenulum compared to the diagnostic intervals classified according to Kotlow and Ruffoli (Graph 1) indicate that all patients have a frenulum now physiological (length >2 cm and tip distance of the tongue, lingual insertion of the frenulum >16 mm). The change in the length of the frenulum before and after surgery is significant for $p < 0.05$ with an average increase in the length of the frenulum of about 9 mm. It was also observed, comparing the photographic studies of the postural post and post-surgery positions, a decrease in the anteriorization of the head in some cases in the two subsequent checks.

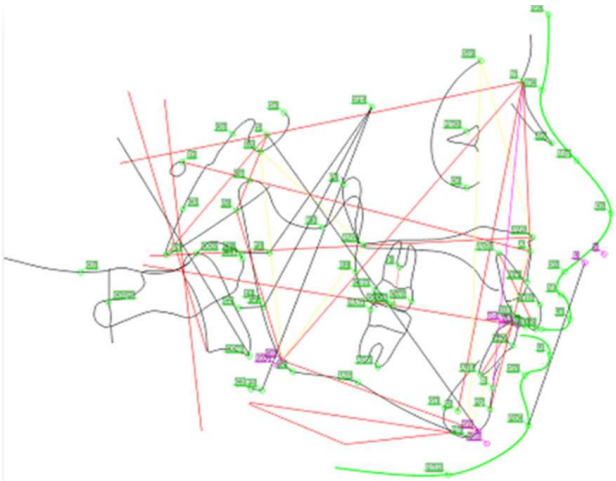
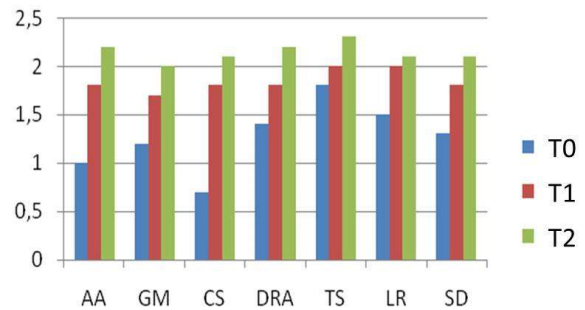


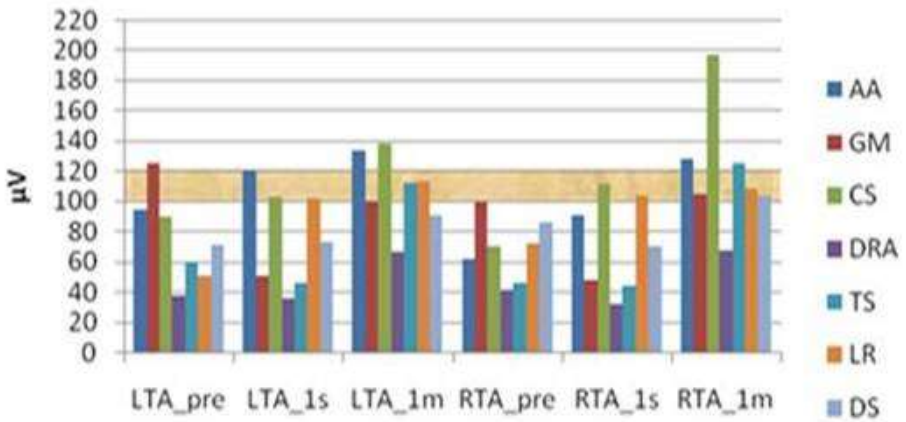
**Fig. 4**. *Cephalometric analysis.*



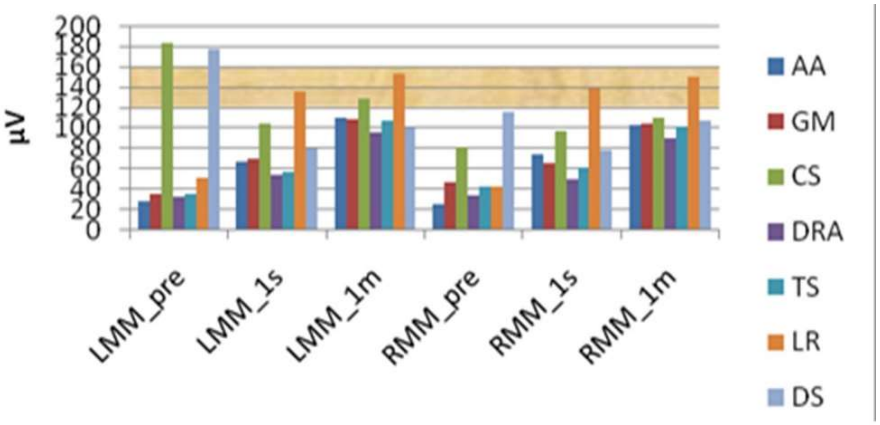

**Graph 1**. *Results at T0-T1-T2 according to Ruffoli's classification.*

Romberg's test after frenectomy testified to an improvement in static balance. The cephalometric tracing according to Rocabado confirmed these observations as it identifies a lowering of the hyoid on average of 2.5 mm ($p < 0.05$) with respect to the position prior to the intervention. This variation is expressed thanks to the decrease in the static and dynamic hypertonia of the suprahyoid (mylohyoid, genihyoid, digastric and hyoid stylus) and extrinsic lingual (genioglossus, palatoglossus, ioglossus, styloglossus) muscles which were previously markedly tense due to the lingual functional deficit due to short frenum. Furthermore, the lordosis angle (5°±2°) and the cranio cervical angle (96°±5°) in the post-frenectomy cephalometric tracing identify a normalization of the cervical curve on physiological parameters, previously too lordotic (8°) or too much "rectilinear".

In the preoperative electromyographic tracing, a difference in terms of μV was observed between the activity of the masseters more and more balanced compared to that of thunderstorms both at rest and at basal function. After the operation, these differences were canceled, reaching a similar and normal electrical activity on both sides in each of




**Graph 2**. *Results of sEMG on anterior temporal muscles.*




**Graph 3**. *Results of sEMG on masseter muscles.*

the two controls after cutting the frenulum. It is no coincidence that the change in the electrical activity of thunderstorms in the last measurement compared to the first was significant for $p < 0.05$ in the window frame on cotton rollers (Graph 2 Temporal muscle) (Graph 3 Masseter muscle).

## DISCUSSION

Lingual laser frenectomy is a minimally invasive technique thanks to which the patient acquires good mobility and lingual functionality (100-103), however, the disadvantageous anatomical condition of the short frenulum not only affects the stomatognathic system but thanks to the results of the study it seems to be correlated with postural problems, evidenced by the incorrect position of the hyoid bone and by a different curvature of the cervical vertebrae by a few degrees from the norm. In fact, the data after the frenulum cut collected at one week and one month confirm the improvement of these anomalies.

This change is thought to be attributable to a reduction in the muscle activity of over hyoid bone and lingual extrinsic muscles which with short lingual frenulum are hypertonic and contracted both in a static and dynamic position. The hyoid bone, joined and pushed by these muscles upwards, transfers part of the tension to the other muscles related to it, especially under hyoide bone. This can create a series of postural imbalances that are expressed in an anteriorization of the head and shoulders with a shift of the body center of gravity towards the front. Consequently, the back of the body is also treated forward, thus causing an accentuation of the cervical lordosis visible in two treated patients (40) (Fig. 5).

In the other patients, on the other hand, despite a drop in the hyoid bone after surgery, a consequence of a decrease in the muscle tone as in the first group, the initial lordotic curve is barely sketched (lordosis angle of 2°) and the cut of the frenulum leads to an increase of some degree of cervical lordosis so as to make it physiological (Fig. 6). In this case, it is possible that a compensation mechanism of the posterior spinal and cervical muscles is implemented, ready to counteract the hypertonicity and contraction of the anterior upper hyoide muscles that, through the hyoid, transfer the tension to all the muscles that join it. In favor of this hypothesis, it may be useful to remember that the stomatognathic system is the meeting point of the anterior and posterior postural muscle chains (104-106) therefore, an anterior tension could be counteracted posteriorly by the posterior chain generating an adaptation which decreases the degree of physiological lordosis thanks to the muscular contraction that generates flexion of the column.

The frenectomy smoothens the anterior muscle tension and therefore the posterior adaptive stimulus could consequently be lacking, by now missing the anterior contraction, thus generating a normalization of the cervical curvature. Furthermore, the signaling of an improvement in electrical activity towards the

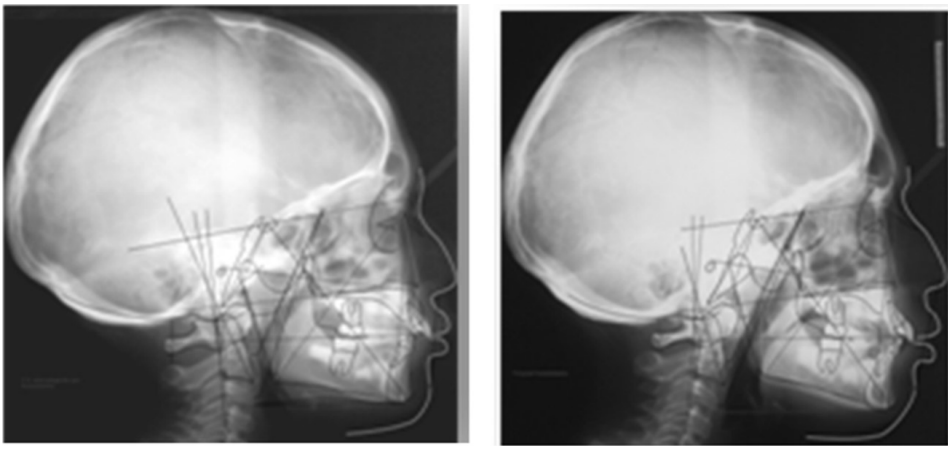


**Fig. 5**. *Comparison between cephalometric analysis before and after laser lingual frenectomy in the same patient.*

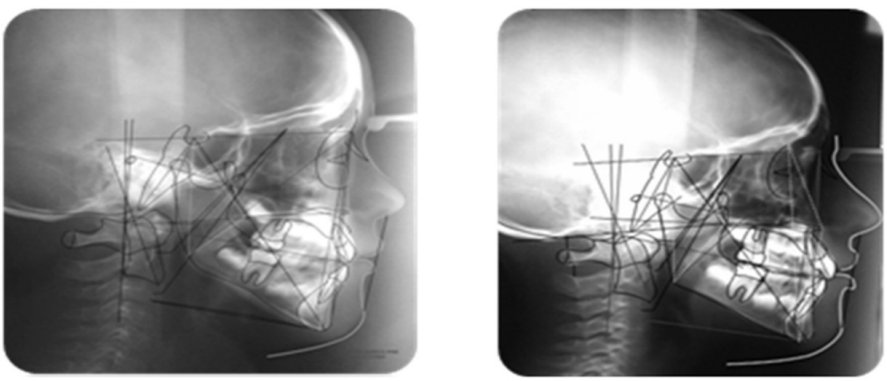


**Fig. 6**. *Comparison between cephalometric analysis before and after laser lingual frenectomy in the same patient.*

physiological intervals of the electromyographic values of the chewing muscles investigated further testifies that frenectomy leads to a regularization of muscle tone and a more adequate mandibular posture. Another possible hypothesis useful to explain the two different groups (less lordotic, more lordotic) at the initial detection could be the correlation with the skeletal class. The largest group is hypolordotic and has two third classes within it that many authors (107) associate precisely with cervical hypolordosis while the initial hyperlordotic group consists of two second classes that in the literature the same authors related to hyperlordosis.

Moreover, in the hypolordotic group two individuals have values tending to the third class (Witts index and ANB angle), despite being first skeletal classes. An individual appears to have open bite and be hyperdivergent with bilateral cross bite. In literature some authors (15, 78) argue that such situations lead to hypolordosis. However, the cephalometric values measured with the Giannì trace demonstrate a substantial absence of variations in the values of the post-surgery skeletal and dental classes. The fact that cutting the frenulum modifies postural relationships and decreases muscle tension does not lead to a short-term variation of malocclusions in the 7 patients. So, the hypothesis of relations with the skeletal classes is not entirely solid.

Other characteristics (bite, width of the gonic angle, vertical dimension, cavism or flatness of the foot) can be taken into consideration to try to explain the cause of the initial diversification of the column which after section of the frenulum assumes in both cases a physiological posture (16, 26, 31, 40). However, none of the theories can fully explain this diversification. So, what we know for sure is that the

regularization of the physiological length frenulum not only frees the tongue but also eliminates all the postural imbalances generated by lingual hypomobility. In this regard, it is useful to report that the postural evaluation in the two post-intervention checks indicates a more adequate symmetry between the parts and a decrease in the anteriorization of the head and shoulders in some individuals.

The Romberg test indicates an improvement in the static balance, a sign that the postural disturbances discussed earlier would have decreased or even eliminated. However, the considerations made so far are based on a small number of patients, therefore they cannot be considered applicable in a standardized way to the general population. The continuation of the study with the acquisition of new cases and new data may determine the hypotheses with more certainty and in a more statistically significant way.

The research carried out, still in the experimental and perfecting phase, wants to give the clinician the opportunity to understand that the short lingual frenulum has not only implications with the stomatognathic apparatus but also wider problems such as relationships with the cervical and body posture. From the data collected from this work it has been seen that cutting the short frenulum would seem not only to improve the properly lingual functions but also to correct the postural anomalies associated with it.

Frenectomy allows the achievement of basal eutonia by rapid macro adjustment involving muscles and bones during the natural homeostasis achieving a normalization of general balance. This statement will be confirmed with the continuation of the study and the collection of other data with the possibility of giving greater scientificity to the above hypotheses. Frenectomy is an adequate intervention in patients with short lingual frenulum for the acquisition of lingual functions (swallowing and phonation in the first place) and the laser assisted method turns out to be one of the least invasive and fast-performing surgical techniques present today; it promotes a reduction in the imbalances of the muscle tone of the anterior masseter and temporal chewing muscles both at rest and in basal function, favoring a lowering of the hyoid bone from an advanced position to a more physiological one thanks to the decrease in the suprioid muscle tension. Frenectomy favors a normalization of the degree of lordotic curvature in patients with mild hypo (third skeletal classes and first skeletal classes tending to the third) or hyperlordosis (second skeletal classes) and improves the patient's static and dynamic balance by moving towards a normal position of the body's center of gravity while established basal eutonia obtained by natural homeostasis achieves a normalization of general balance.

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# Zygomatic implants supported rehabilitations in atrophic maxilla: sinus complications, radiological, periodontal and prosthodontic evaluations: a one year follow up retrospective longitudinal study

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**The rehabilitation of maxillary bone atrophy represents one of the main challenges of modern oral implantology. The use of zygomatic implants in the prosthetic rehabilitation of the patient affected by severe maxillary bone atrophy is another therapeutic alternative, not exempt from complications. The present study included 19 patients with edentulous maxillae who were treated between 2013 to 2015 with at least two zygomatic implants at the Department of Maxillofacial Surgery, Verona, Italy. The purpose of this retrospective longitudinal study was to evaluate sinus complications and radiological, periodontal and prosthetic evaluations of zygomatic implants technique in severe atrophic. Implant-prosthetic rehabilitation of the upper jaw edentulous severely atrophic using zygomatic implants represents one safe and repeatable technique. In terms of implant survival from our study showed an implant CRS (common reporting standard) of 98.5% and a prosthetic CRS 100% with a mean follow-up period of 19.2 months (range). Both recorded data are superimposed on major reported studies in literature.**

The rehabilitation of maxillary bone atrophy represents one of the main challenges of modern oral implantology. The use of zygomatic implants in the prosthetic rehabilitation of the patient affected by severe maxillary bone atrophy is another therapeutic alternative, not exempt from complications. The present study included 19 patients with edentulous maxillae who were treated between 2013 to 2015 with at least two zygomatic implants at the Department of Maxillofacial Surgery, Verona, Italy.

The purpose of this retrospective longitudinal study was to evaluate sinus complications and radiological, periodontal and prosthetic evaluations of zygomatic implants technique in severe atrophic. Implant-prosthetic rehabilitation of the upper jaw edentulous severely atrophic using zygomatic implants represents one safe and repeatable technique. In terms of implant survival from our study showed an implant CRS (common reporting standard) of 98.5% and a prosthetic CRS 100% with a mean follow-up period of 19.2 month (range). Both recorded data are superimposed on major reported studies in literature. The great advantage of this type of rehabilitation is not only to minimize postoperative morbidity caused by massive reconstructive surgeries (1-4) such as bone grafting (5-15) or sinus floor elevation, but also to eliminate hospitalization, high cost and risk of complications.

The placement of dental implants in the zygomatic bone, introduced by Branemark in

*Key words: maxillary bone atrophy, edentulous maxillae, Implant-prosthetic rehabilitation, zygomatic implants*

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1988, is an alternative technique that can facilitate the rehabilitation procedures in severely atrophic maxilla and maxillectomy defects (16-18), pre prosthetic surgery following ablative tumor surgery (19), congenital clef lip and or palate (20). Zygomatic implants have been used in conjunction with regular implants or alone in the number of four when the premaxilla presents severely resorbed. The main objective of the present article is to draw a retrospective longitudinal study to evaluate the cumulative zygomatic implants survival rate and peri-implant soft tissues condition and complications at the one-year follow-up.

## MATERIALS AND METHODS

The study included 19 patients (9 males and 10 females) range 46- to 88- years-old (mean age 66+/-12 years) with edentulous maxillae who were treated between 2013 to 2015 with at least two zygomatic implants at the Department of Maxillofacial Surgery, Verona, Italy. The patients enrolled in this study met the following inclusion criteria:

- affected by V-VI or VII Cadwood Howell (21) Nocini (22-23) class maxillary atrophy evaluated through a pre- and post-surgery TC cone beam at least 12 months prior;
- good general/local health which allowed them to undergo this kind of surgical treatment;
- treated with at least two zygomatic implants;
- able to receive a full arch prosthodontics rehabilitation such as Toronto Bridge or other kind of overdentures for six months loading.

Patients were excluded if they fulfilled any of the following exclusion criteria:

- previously treated with zygomatic implants not for atrophic disease;
- not affected by allergic rhinitis;
- not previously treated with sinus surgery;
- addicted to smoking;
- lack of clinical documentation.

All these patients showed an insufficient bone volume for traditional implant treatment. However, for 6 patients, a generic medical history revealed a positive anamnesis: 2 diabetes type II, 1 HIV+, 1 HBV+, 2 HCV+, 1 Parkinson, 1 mucoviscidosis and chronic pancreatitis. All patients received a detailed description of the procedures and signed an informed consent prior to participation in the study. The study was conducted according to the principles embodied in the Helsinki declaration, as revised in the 2000, for biomedical research involving human subjects. Patients who were included in the study were carefully evaluated by examining the clinical aspects and periapical/panoramic radiographs and computer tomograms (CT); moreover, data were collected for each patient at the implants placement phase (T0), at the prosthodontic loading (T1) and at the follow up date (T2) and reported in Table I.

After the surgical phase, 5 patients received two Zygomatic Implants (ZI) and four dental implants in the premaxilla; other 12 patients had 4 ZI (Quad Technique), one patient had three ZI and two dental implants and one pterygoid implant, one patient had two ZI and three dental implants in the premaxilla. After prosthodontic phase, 13 patients were rehabilitated through a Toronto Bridge fixed full arch, meanwhile other 9 patients received an overdenture.

Panoramic images supplemented with intraoral radiographs were used preoperatively to evaluate the bone volume of the maxilla. Computed tomograms (CT) were used to determine whether the anatomy would allow installation of zygomatic implants (24) and to eliminate

**Table I**. *Documentation between T0 and T2.*

| |
|---|
| ***Preoperative documentation*** |
| Orthopantomographies of the dental arches |
| Intraoral radiographs of the implant sites |
| Lateral teleradiography |
| CBCT of the facial massif |
| Preoperative clinical photos |
| ***Intraoperative documentation (T0)*** |
| Clinical photos with open flap |
| Clinical photos of implant placement |
| Clinical photos with suture |
| ***Postoperative documentation*** |
| Orthopantomographies of the dental arches |
| Clinical photos before hospital discharge |
| Hospital discharge letters |
| ***Follow up documentation (T2)*** |
| Clinical photos before and after disassembly of the prosthesis |
| Extraoral photos of the prosthesis |
| CBCT of the facial massif for evaluation of the zygomatic bone |

the risk of undiagnosed pathologic lesions.

Preoperative Cadwood Howell Nocini Classification was assessed for each patient ranging from V to VI. Postoperatively a new CT was performed at least 12 months after surgery. Pre surgical Protocol: presurgical exams were detected to analyze bone amount in each patient, i.e. panoramic exam, intraoral radiographs, teleradiographs L-L and Cone Beam TC of the maxillo facial process to accurately evaluate anatomic structures. Evaluation was carried out on the size of the malar bone and Higmoro antrum, the topography of the front wall of the temporal fossa, the degree of pneumatization of maxillary sinus, the thickness of the alveolar process in the premolar area, the degree of bone atrophy and the skeletal relationship between jaws (Fig. 1).

In order to carry out the most prosthetically guided surgery, it was crucial to study the angularity and the expected emergency position of zygomatic implants: this emergency at the alveolar ridge depends on the spatial relationship between the zygomatic bone, the maxillary sinus and the Alveolar crest. Acute phase sinus pathology and/or signs/symptoms of tissue infection (25-30) surrounding the site insertion area are also evaluated. Where present an adequate amount of bone in the pre-maxilla area it was decided to place two to four conventional implants (31-33), to avoid any bone grafts and best distribution in prosthetic cargo. The position and angle of the conventional rear implant was determined based on the maxillary sinus anatomy, anterior wall.

Surgery was performed under general anesthesia with nasal endotracheal intubation supplemented with infiltration of local anesthetic agents with a vasoconstrictor for hemostasis. Patients were given benzylpenicillin (3g) and metronidazole (0.5g) preoperatively routinely. A crestal incision was made bilaterally extending from the second upper molar. A vestibular releasing incision was made at the posterior extent of the incision in the maxillary second molar region. A mucoperiostal flap elevation revealed the nasal apertures and the piriform rim to the inferior aspect of the infraorbital foramina and laterally of

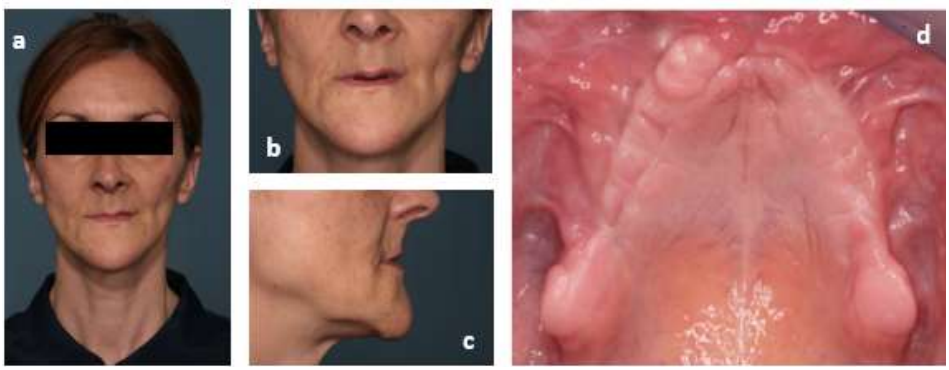


**Fig. 1**. *Intra-operatory documentation.* ***a****): front view of edentulous atrophic patient, closed lips;* ***b****): details of edentulous atrophic patient's mouth and the lack in trophism of perioral tissues;* ***c****): right profile of edentulous atrophic patient, closed lips;* ***d****): occlusal view of the patient's atrophic Maxilla, VII class Cawood and Howell.*

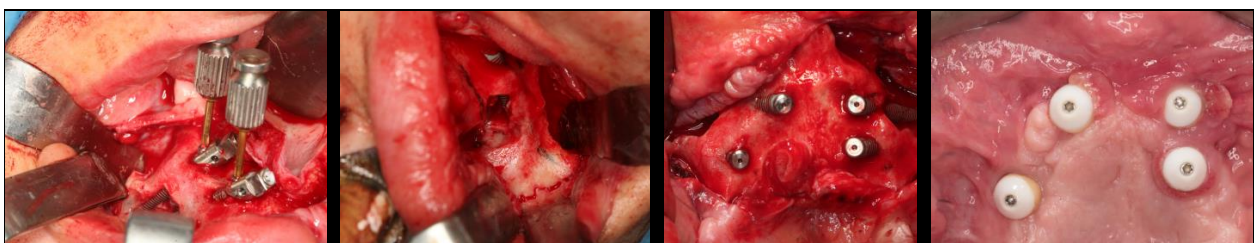

**Fig. 2**. ***From left to right****: Intra-operatory check of prosthetic parallelism after Zygomatic implants insertion; Intra-operatory fracture of Zygomatic arch during zygomatic implants drilling; Intra-operatory occlusal view of Zygomatic implants position; Occlusal view of Zygomatic implants position with healing caps.*

the buttress and body of the zygoma bilaterally.

A round bur rather than piezosurgery tools (34-35) was then used to create a lateral window, 5x10 mm, in the lateral wall of the maxillary sinus. The sinus mucosa was then carefully reflected and protected through the preparation of the zygomatic implant site. A retractor was placed over the superior aspect of the zygomatic arch to enable correct orientation of the implant site preparation. The zygomatic implant heads were placed palatally and as close as possible to the alveolar crest, in the region of the second premolar and first molar. After penetrating the maxillary bone into the maxillary sinus, the preparation was penetrating the cortical layer of the anterior superior part of the zygomatic bone.

The implant sites were then enlarged. Implant size was determined, and final placement of the implant was accomplished using the standard protocol. The zygomatic implant was placed using a low speed until the tip of the implant engaged the zygomatictic bone and was finalized manually until the implant was optimally seated. All 31 zygomatic implants had a stable and ridged primary stability at the installation and were dressed in a cover screw. Patients obtained immediate placement of additional endosseous implants (36-39) in the anterior region of the maxilla (Branemark System, Nobel Biocare AB, Goteborg, Sweden). The wound was closed with a continuous, absorbable 4-0 suture. Postoperatively, the patients were prescribed antibiotics for 1 week. Abutment connection surgery was performed after a healing time of 5 to 8 months (mean 6.4 months).

*Prosthetic Protocol*

The conventional dentures were relined after implant surgery and after abutment connection and were worn provisionally in the healing periods. Fabrication of Toronto Bridge or overdentures implant supported fixed prostheses followed the standard procedures for the implant treatment, as described in literature (40-42). The fixed prosthesis was finally handed out 4 months after the abutment connection procedure. All patients were enrolled in a personally tailored supportive periodontal maintenance program; in this study all patients were maintained with oral hygiene instructions, or air polishing (glycin powder) on an individual basis according to their needs.

*Follow Up*

Input measures examinations and study variables analysis. Data were collected after zygomatic implants placement (baseline or Time 0), at time 1 and time 2; data were retrospectively analyzed according to a research protocol. An examiner not involved in performing the surgical treatment, took all the measurements as outlined below:

- age and gender as demographic variables at T 0,
- surgical technique according to Aparicio's classification (43),

**Fig. 3**. ***Top line from left to right****: front view of the full-mouth prosthetic rehabilitation in occlusal position; left-side view; right-side view;* ***Bottom line from left to right****: occlusal view of the zygomatic overdenture rehabilitation; occlusal view of the overdenture bar on Zygomatic implants with retentive pins; front view of the transversal relation between the overdenture bar and the inferior prosthetic rehabilitation.*

- type and number of implants placed,
- perimplant Pocket Probing Depth (PPD),
- Mombelli Bleeeding Index (44) (MBI): was measured with a periodontal probe (Hu-Friedy, PGF- GFS, Hu-Friedy, Chicago, IL, USA) at the buccal (mesial, vestibular and distal) and palatal surfaces,
- Mombelli Plaque Index (MPI): was measured with a periodontal probe (Hu-Friedy, PGF- GFS, HuFriedy, Chicago, IL, USA) at the buccal (mesial, vestibular and distal) and palatal surfaces,
- Implant surgery-Prosthesis evaluation: measure of prosthetic screw torque at T1 and T2; moreover, patients had to compile a Visual Analogue Scale (VAS), satisfaction questionnaire about aesthetic, function and phonetic.
- radiological and clinical analysis of the maxillary sinuses: evaluated on Cone Beam CT scan (CBCT, NewTom 3G). The data acquisition was set through a single rotation of the device, with 59μSv radiant dose for each patient. Coronal, axial and sagittal images were obtained for each implant considered in this study. The osteointegrated portion of the zygomatic bone was calculated using a specific medical imaging viewer: Radiant DICOM Viewer (Radiant DICOM ViewerTM, Medixant, Poznan, Poland).

Nineteen patients received zygomatic implant treatment and were included in the study. All patients were contacted for a further prospective follow-up examination. Subsequently the patients underwent clinical and radiographic examination according to the prospective follow-up protocol.

## RESULTS

Implant Stability: nineteen patients were treated with 63 zygomatic implants (Branemark System) with lengths range from 35 to 50 mm. One patient was treated with 2 unilateral zygomatic implant, one patient received 3 zygomatic implants, 12 patients received 4 zygomatic implants (quad technique) and 5 patients had 2 zygomatic implants bilaterally (see Table II). Twenty-six additional dental implants (Bra°nemark System or Astra Tech Dental Implant System) were placed (see Table II). Out of 19 patients, 17 were non-smokers and 2 (one male/ one female) were smokers (20 cigarettes in a day). Serious maxillary bone defects were caused in 14 cases (7 males and 7 females) from periodontitis disease, in 1 case (1 male) by upper cystic process, in another 1 case by partial maxillectomy due to an atypical lymphoproliferative process with a rich follicular component (1 female), 2 cases of previous implant failure (2 females) and 1 trauma case (1 male) (Table II).

Post-surgery complications (45-49): one zygomatic implant, in one patient, was removed after a car crash trauma. After a mean follow-up period of 19.2 months (range), the overall cumulative survival rate (CSR) was 94.3%. After the prosthetic loading of the implants the survival percentage was 100%. The follow-up period ranged from 105 to 2483 days from the day of prosthesis delivery, with a mean of 570.52 days (3 years, 10 months). From the patient records, the following parameters were recorded: Soft Tissues: the mean PPD was 3.16 mm (dev. St.±1.75 range 1-11). The mean mPI was 0.7 (dev. St.±0.9 range 0-3). The mean mBI was 0.54 (dev. St.±0.7 range 0-2). It was not necessary a soft tissue augmentation around the implant exit point (50-65).

**Table II**. *Dermographic variables.*

| ***Variables*** | ***Results*** |
|---|---|
| *Patients (n=19)* | 19 |
| *Male* | 9 (47%) |
| *Female* | 10 (53%) |
| *Age (average value and range)* | 66 (46-88) |
| *Loading (day) – average value* | 276,21 |
| *Follow-up (day) average value* | 570,52 |
| *Total implant number* | 63 |
| ***Surgical technique*** | |
| *Intrasinusal* | 17 |
| *Extrasinusal* | 2 |
| *Quad* | 12 |
| *2 Zygoma + 4 traditional* | 5 |
| *2 Zygoma + 3 traditional* | 1 |
| *2 Zygoma + 1 pterigoid + 2 traditional* | 1 |

*Prosthetic components analysis*

Overall, the torque of 63 prosthetic screws was evaluated: at T1 the mean torque was 15.68 Ncm (dev st±8.41 Ncm range 0-30 Ncm). T2 torque of MUA screw was evaluated to investigate possible unscrewings: at T1 it was serried with 15-18 Ncm. 37 screw on MUA were analyzed: the mean torque was 11.81 Ncm (dev st 4.23 Ncm range0-17 Ncm).

*Prosthesis satisfaction*

The definitive prosthesis was delivered to the patient 4 months after surgery. It had been performed 13 Toronto Bridge and 6 overdentures. A prosthetic questionnaire for the evaluation of the satisfaction (56) based on Visual Analogue Scale (VAS) was given to the patients. It was formed by three parts: function (mean VAS 9.3/10), aesthetic (mean VAS 9.7/10) and phonetic (mean VAS 9.2/10).

*Maxillary sinuses*

The presence of sinusitis was radiologically evaluated according to the Lund and Mackay CT scoring rhinological staging system. So, evaluation of the maxillary sinuses was executed before surgery (mean 0.078±0.27) and after 6 months (0.26±0.5) to evaluate the differences between the two values obtained.

*Entities of rhinosinusal symptomatology*

For each patient, the Questionnaire SNOT-20 (Sino-Nasal Outcome Test) was collected before and after surgery with a minimum 12 months follow up. This tool evaluates a wide range of parameters including health, the Quality of life, physical problems, functional limitations and emotional consequences. (Lachanas et al. 2012). This study has been used to standardize the evaluation of the symptoms pool referred by the patients. Clinical analysis of maxillary sinuses the magnitude of symptomatology of rhinitis-sinus relevance has been evaluated through the administration of the SNOT-20 questionnaire.

In detail, the Preoperative assessment 17 out of 19 patients showed a score Ranging from 0 to 10. The remaining 2 patients reported a score Between 11 and 40 None of these patients considered their disease to be significantly affected Quality of life, limiting the management of any therapy symptoms to the need. The SNOT-20 total score for this sample in the survey Preoperative was 49 points, with an average score of 2.58±6.61, while in the postoperative survey the total score of the sample Was 80 points, with an average of 4.21±6.93. At postoperative evaluation, 16 out of 19 patients reported a score ranging from 0 to 10. Instead, the remaining 3 patients reported a score between 11 and 40.

## DISCUSSION

The purpose of this retrospective longitudinal study was to evaluate sinusal complications and a radiological, periodontal, prosthetic evaluations of zygomatic implants technique in severe atrophic at the 1 year follow up.

*Surgery*

After surgical procedures, we did not register any intraoperative complications; immediately after surgery we only found one implant failure before the prosthetic loading. This study reported implant and prosthetic survival rates so similar to other Authors' clinical experiences.

*Prosthetic parameters*

In this longitudinal retrospective study, a total of 19 patients were screened for a total of 63 implants and 19 prosthetic rehabilitation. The Med Calc (Med Calc Software bvba, Ostend, Belgium) software was used for statistical analysis. The Mann-Whitney U test for independent variables (level of significance a $P<0.05$) tested data collected by all 19 patients to determine the possible correlation between the kind of prosthetic rehabilitation and torque measured on the prosthetic screws. It revealed that no statistically significant differences between torque levels on prosthetic screws in non- removable prostheses and Toronto Bridge's ones related to the loading time ($P>0.05$).

The same Mann Whitney test was used to evaluate the possible correlation between the kind of prosthetic rehabilitation and torque levels measured on the MUA screws. ($P>0.05$). For measurements collected at 1.2, it was not possible to carry out the

Mann Whitney U test due to insufficient samples number. Otherwise, it showed no significant differences in torque registered level on screws between overdenture and Toronto in other sites. In all these cases a P>0.05 was provided.

Therefore, there is no statistically relevant correlation between the type of prosthetic solution adopted and possible tensile stresses at the prosthetic screw and MUA. All the authors decided to evaluate the possible correlations between type of prosthesis and the measurement of Pocket Depth (PD) at T2 using the same Mann Whitney U test with a statistical significance value of P<0.05. The text revealed a correlation between prosthesis type and PD at T2 with a P<0.05. We observed that two posterior implants 1.4 and 2.4 showed most significant differences. Particularly posterior zygoma implants in overdentures showed higher values of PD than ones in Toronto.

The same statistical test was carried out to analyze the relationship between the follow-up survey bleeding and the type of prosthetic solution. There was no statistical significance from this test that could justify a correlation between the type of prosthesis and the bleeding indices recorded at follow-up. Implanted rehabilitations require, for long-term survival, a great home hygiene by the patient, in order to evaluate which of the two prosthetic solutions provides greater cleanability, the Mann-Whitney test for independent variables Two-tier, correlating the type of prosthesis with plaque indexes recorded at the follow up visit.

The test showed that there are statistically significant differences in 2 sites (1.4 P and 2.4 P) in which the amount of plaque detected was found significantly greater in unmistakable prostheses than Toronto. The question of prosthetic satisfaction has provided results. In line with what was reported in the literature by a 12-month analysis from the load reported by Peñarrocha (63).

*Radiographic indices*

Based on Wilcoxon's Row Test for dependent variables, there is a statistically significant increase (p <0.0002) of the magnitude of the postoperative radiological evidence of rhinosinus pathology compared to preoperative evidence. Based on the Lund-Mackay score, the presence of rhinosinus or of mucosal alterations was evaluated by tapered CT in the coronal sections. In detail, no patient had preoperative evaluation total radiopacity of the maxillary sinuses (LMS=2+2). Three patients showed up unilateral mucous membrane (LMS=1). The remaining patients had bilateral radiotransparency (LMS=0) of the maxillary sinuses. Altogether, there were 35 breasts in the preoperative evaluation jaws with LMS equal to 0.3 maxillary sinuses with LMS equal to 1 and 0 breasts jaws with LMS equal to 2.

Clinical analysis of maxillary sinuses: the magnitude of symptomatology of rhinitis-sinus relevance has been evaluated through the administration of the SNOT-20 questionnaire. In detail, the preoperative assessment 17 out of 19 patients showed a score ranging from 0 to 10. The remaining 2 patients reported a score between 11 and 40. None of these patients considered their own symptomatically affected quality of life, limiting the management of any therapy symptoms to the need. At postoperative evaluation, 16 out of 19 patients showed a score from 0 to 10. The remaining 3 patients reported a score between 11 and 40 (89%-11%).

The SNOT-20 total score for this sample in the survey preoperative was 49 points, with an average score of 2.58±6.61, while in the postoperative survey the total score of the sample was 80 points, with an average of 4.21±6.93. Hirsch (Hirsch, et al. 2004) also used the VAS scale for 2004 evaluate the chewing function and the aesthetics of 76 patients rehabilitated with zygomatic implants after 1 year of prosthetic cargo. The 80% of patients were completely satisfied with both aesthetics and asthma for the function.

Comparison of the degree of prosthetic satisfaction, reported in the literature and that recorded by our study, showed 110 fully satisfied with the rehabilitation while the other half of the patients found difficulty in chewing and problems related to oral hygiene, aesthetics and phonetics. Farzad et al. (66) analyzing the answers to questionnaires satisfaction delivered to 11 patients before and after implantoprosthetic rehabilitation, finds statistically significant differences with respect to chewing and

aesthetics but does not find significant changes in the language.

*Radiographic indices*

Based on Wilcoxon's Ranks Test for Employee Variables there is a statistically significant increase ($p < 0.0002$) of the entity of postoperative radiological evidence of rhinosinus pathology to preoperative evidence. Inizio modulo

*Clinical analysis of maxillary sinuses*

Based on Wilcoxon's Row Test for Employee Variables there is no statistically significant increase ($p=0.1$) of the magnitude of rhinosinus symptomatology compared to preoperative.

The clinical and radiological retrospective retrospective study allowed to highlight the following results: implant-prosthetic rehabilitation of the upper jaw edentulous severely atrophic using zygomatic implants represents onesafe and repeatable technique. In terms of implant survival from ours. The study showed an implant CRS of 98.5% and a prosthetic CRS 100%. Both recorded data are superimposed on those reported in major studies in literature.

As for implant survival it was also not detected no statistically significant difference between the various techniques of zygomatic implant insertion, which are therefore overlapping. The analysis of prosthetic components did not show correlations or statistically significant differences between inammapurable prostheses and the Toronto Bridge prostheses, both with respect to the torque values recorded on the prosthetic screws, as well as the torque values recorded at the screws of MUA.

The analysis of periodontal parameters related to the type of prosthesis has produced statistically significant results with regard to depth of the survey, despite the resulting depth values of the poll (PD) greater in, intact, removable prostheses has not found any clinical significance since the modified bleeding index associated with the type of prosthesis has produced statistically significant results. The modified plaque index showed a greater accumulation of palatal plaque at the zygomatic rear implant (1.4 and 2.4) with unmovable prosthesis, this could reflect a greater difficulty in detaching the patient's in-removable implant prosthesis posteriorly due to its conformation.

The radiologic analysis of paranasal sinuses, subjected to zygomatic implantation, showed a statistically significant increase in Lund-Mackay Postoperative Score. The rise of radiologic sinusitis, elsewhere already described as silent sinusitis, does not correspond, and does not correlates with a statistically significant increase in clinical symptoms since SNOT20 postoperative values did not record significant variations. Long-term monitoring and follow-ups is necessary in order to verify the actual incidence of sinusopathies related to the presence of transient zygomatic implants. To conclude, we can say that implant prosthetic rehabilitation through zygomatic implants in cases of extreme atrophy of the edentulous upper jaw is a good alternative to those more invasive procedures such as Le Fort I intervention with interposition grafts or revascularized free flaps characterized by a larger Surgical complexity, a more burdensome post-operative course for the patient, and a greater chance of failure.

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