UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ODONTOLOGIA DE BAURU

VINICIUS LARANJEIRA BARBOSA DA SILVA

**Long-term stability of surgical-orthodontic open bite treatment:
Le Fort I versus 4-piece segmental Le Fort I osteotomy**

**Estabilidade em longo prazo do tratamento cirúrgico da mordida
aberta anterior por osteotomia tipo Le Fort I com e sem
segmentação maxilar**

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Tese constituída por artigos apresentada a Faculdade de Odontologia de Bauru da Universidade de São Paulo para obtenção do título de Doutor em Ciências no Programa de Ciências Odontológicas Aplicadas, na área de concentração Ortodontia.

Orientador: Prof. Dr. Guilherme Janson

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“A melhor maneira de prever nosso futuro é construí-lo”.

Abraham Lincoln

ABSTRACT

ABSTRACT

Long-term stability of surgical-orthodontic open bite treatment: Le Fort I versus 4-piece segmental Le Fort I osteotomy

Introduction: This vertical malocclusion has the potential of causing functional and esthetic impairment, impacting patients' quality of life negatively. The long-term stability of anterior open bite surgical-orthodontic treatment is an important and controversial issue. A variety of factors such as surgery type, surgery fixation, and the anteroposterior discrepancy is related to and can influence long-term overbite stability. The controversy of stability arises in the inherent difficulty of collecting a homogeneous sample, with considerable sample size and adequate long-term follow-up, leading the current literature to an inconclusive status. Therefore this thesis aimed to test 2 null hypotheses: 1- There is no difference in the long-term stability of the surgical-orthodontic correction of anterior open bite when comparing Le Fort I to 4-piece segmental Le Fort I osteotomies. 2- To test the null hypothesis that there is no difference in the long-term stability of the surgical-orthodontic correction of anterior open bite when comparing Class II to Class III patients. **Materials and Methods:** The sample of the first investigation comprised the lateral cephs of 29 open bite subjects treated with 1-piece Lefort I osteotomy compared to the lateral cephs of 24 open bite subjects treated with 4-piece Lefort I osteotomy; in both groups Class I, II and III subjects were included. The groups were matched regarding age and were compared with t-tests. To test the second null hypothesis, lateral cephs of 21 Class II open bite subjects were compared to lateral cephs of 25 Class III open bite subjects. Overbite changes were compared at 3-time points: T1 (pretreatment), T2 (posttreatment) and T3 (follow-up) by using t-test. Overbite clinical stability percentage at T3 was assessed with the chi-square test. **Results:** In 1-piece Le Fort I Group 65.52% of patients presented with clinically significant overbite stability, while in 4-piece Group 83.33% remained stable in the long-term, however it was not statistically significant. In Class II Group 57.14% of patients presented with clinically significant overbite stability, while in Class III Group 88% remained clinically stable, and it was statistically significant. **Conclusions:** The first null hypothesis regarding

maxillary segmentation was accepted because there was no significant intergroup difference regarding the percentage of clinically stable patients. The type of fixation seems to influence the long-term stability of open bite surgical-orthodontic correction more than maxillary segmentation. The second null hypothesis was rejected because clinical stability of Class II malocclusion open bite surgical-orthodontic treatment was significantly smaller than in Class III malocclusions.

Keywords: Open bite. Orthognathic surgery. Angle class II. Angle class III

RESUMO

RESUMO

Estabilidade em longo prazo do tratamento cirúrgico da mordida aberta anterior por osteotomia tipo Le Fort I com e sem segmentação maxilar

Introdução: A estabilidade em longo prazo do tratamento orto-cirúrgico da mordida aberta anterior é um assunto relevante e controverso. Esta má oclusão vertical tem o potencial de causar importantes alterações tanto funcionais quanto estéticas, impactando negativamente a qualidade de vida dos pacientes. Vários fatores, como o tipo de cirurgia, a fixação cirúrgica e a discrepância ântero-posterior, estão relacionados e podem influenciar a estabilidade da sobremordida em longo prazo. A controvérsia na estabilidade surge na dificuldade inerente de coletar uma amostra homogênea, com um tamanho de amostra considerável e acompanhamento adequado em longo prazo, levando esse assunto na literatura atual a um status inconclusivo. Portanto, esta tese teve como objetivos testar 2 hipóteses nulas: 1- Não há diferença na estabilidade em longo prazo da correção orto-cirúrgica da mordida aberta anterior ao comparar as osteotomias tipo Le Fort I com e sem segmentação maxilar. 2- Não há diferença na estabilidade em longo prazo da correção orto-cirúrgica da mordida aberta anterior ao comparar pacientes com má oclusão de Classe II e Classe III. **Materiais e Métodos:** A amostra da primeira investigação compreendeu as telerradiografias de 29 indivíduos com mordida aberta tratados por osteotomia Lefort I sem segmentação maxilar, às quais foram comparadas às telerradiografias laterais de 24 indivíduos com mordida aberta tratados por osteotomia Lefort I com segmentação maxilar; pacientes Classe I, II e III foram incluídos. Os grupos foram compatibilizados pela idade e foram comparados com testes t e qui-quadrado. Para testar a segunda hipótese nula, telerradiografias laterais de 21 indivíduos com mordida aberta e má oclusão de Classe II foram comparadas às telerradiografias laterais de 25 indivíduos com mordida aberta e má oclusão de Classe III. As alterações do overbite foram comparadas em três tempos: T1 (pré-tratamento), T2 (pós-tratamento) e T3 (longo-prazo) usando o teste t.

A taxa de estabilidade clínica em T3 foi avaliada com teste de qui-quadrado. **Resultados:** No Grupo Le Fort I sem segmentação maxilar 65,52% dos pacientes apresentaram estabilidade clínica da sobremordida, enquanto que no Grupo Le Fort I com segmentação maxilar, 83,33% mantiveram-se estáveis em longo prazo, porém essa diferença não se apresentou estatisticamente significativa. No Grupo Classe II, 57,14% dos pacientes permaneceram clinicamente estáveis, enquanto que no Grupo Classe III, a porcentagem clínica de estabilidade foi de 88%, e a diferença apresentou significância estatística. **Conclusões:** A primeira hipótese nula em relação à segmentação maxilar foi aceita porque não houve diferença estatisticamente significativa entre os grupos em relação à porcentagem de pacientes clinicamente estáveis. O tipo de fixação parece influenciar a estabilidade em longo prazo da correção orto-cirúrgica da mordida aberta mais do que a segmentação maxilar. A segunda hipótese nula foi rejeitada porque a estabilidade clínica do tratamento orto-cirúrgico da mordida aberta em pacientes com má oclusão de Classe II foi significativamente menor do que nos pacientes com má oclusão de Classe III.

Palavras-chave: Mordida aberta. Cirurgia ortognática. Classe II de Angle. Classe III de Angle

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1 INTRODUCTION

1 INTRODUCTION

Orthodontic treatment must be directed to, not only, correct the malocclusion to address patients' esthetic and functional impairments, but also maintaining its results in the long-term.

Treatment of anterior open bite, as well as many other malocclusions, depends on its aetiology, severity and the time that is set, ranging from the simple abandonment of a deleterious habit to an orthognathic surgery involving both the maxilla and mandible (SUBTELNY; SAKUDA, 1964; REYNEKE, 1988; HUANG, 2002; REYNEKE; FERRETTI, 2007; GREENLEE et al., 2011; FONTES et al., 2012).

Even in surgical approaches for open bite treatment, a considerable high relapse rate has been reported in the literature.(HUANG, 2002; MAIA et al., 2010) Besides that, a wide variety of factors are considered to explain the unsuccessful long-term surgical-orthodontic treatment of open bite patients, such as surgery type and anteroposterior discrepancy (HOPPENREIJS et al., 1997; IANNETTI et al., 2007).

Le Fort I impaction approach is a well-established procedure in open bite surgical correction (EPKER; FISH, 1977; BAILEY et al., 1994b; ISMAIL; LEUNG, 2017). This procedure, advantages, and disadvantages have been extensively reviewed in the literature (OBWEGESER, 1970; PROFFIT; WHITE, 2015). Another option is the multi-segmented Le Fort I osteotomy (REYNEKE, 1988; KAHNBERG, 2007; ISMAIL; LEUNG, 2017), allowing the impaction of the maxilla associated with its advance simultaneously correcting transversal, vertical and anteroposterior discrepancies. There is no consensus regarding the stability when these two approaches are compared in the treatment of skeletal open bites (FISCHER; VON KONOW; BRATTSTRÖM, 2000; ARPORNMAEKLONG; HEGGIE; SHAND, 2003; KRETSCHMER et al., 2010; ISMAIL; LEUNG, 2017). In general, segmentation is indicated when there are transversal impairments. Particularly in open bites, some surgeons consider the presence of a 2-step maxillary occlusal plane as a chief-factor to choose the segmental approach. Multi-segmental osteotomies requires more

surgeon expertise due to the higher risks of damaging dental structure and necrosis at the osteotomy surrounded areas (KAHNBERG; VANNAS-LOFQVIST; ZELLIN, 2005; POSNICK; ADACHIE; CHOI, 2016)

Regarding anteroposterior discrepancy, some studies point out that open bite Class II patients treated surgical-orthodontic ly present a higher overbite relapse rate in the long-term when compared to Class III open bite patients (SWINNEN et al., 2001; MAIA et al., 2010). However, some study design issues, mainly related to sample size limitations and follow-up time, have to lead us to weak evidence on this topic and so motivating these investigations.

There are few consistent and specific studies evaluating the long-term stability of anterior open bite surgical correction (FONTES et al., 2012). Some literature reviews (HUANG, 2002), systematic reviews (SOLANO-HERNANDEZ et al., 2013), and even meta-analyses (GREENLEE et al., 2011; MEDEIROS et al., 2012) were made over the last decade, highlighting the lack of well-designed studies with proper sample sizes and adequate long-term observation period in order to establish a reliable evidence-based status of the stability of the surgical approach when treating open bites. The main problems found in the available studies are related to small sample size, the absence of method error assessment, sample heterogeneity, absence of initial records and short posttreatment time follow-up (SOLANO-HERNANDEZ et al., 2013).

Therefore it is of paramount importance to the orthodontist and to the oral surgeon as well, to know if any difference exists regarding the clinical long-term over bite behavior when different surgical approaches are employed in open bite malocclusion surgical-orthodontic treatment, and if the anteroposterior discrepancy also plays a role in the overbite stability.

2 PURPOSES

2 PURPOSES

The purposes of this thesis are:

- 1- To test the null hypothesis that there is no difference in the long-term stability of the surgical-orthodontic correction of anterior open bite when comparing Le Fort I to 4-piece segmental Le Fort I osteotomies.
- 2- To test the null hypothesis that there is no difference in the long-term stability of the surgical-orthodontic correction of anterior open bite when comparing Class II to Class III patients.

3 ARTICLES

3 ARTICLES

The articles presented in this Thesis were written according to the American Journal of Orthodontics and Dentofacial Orthopedics instructions and guidelines for article submission (Annex E).

- ARTICLE 1 - Long-term stability of surgical-orthodontic open bite treatment: Le Fort I versus 4-piece segmental Le Fort I osteotomy
- ARTICLE 2 - Long-term stability of surgical-orthodontic open bite treatment: Class II versus Class III

3.1 ARTICLE 1

LONG-TERM STABILITY OF SURGICAL-ORTHODONTIC OPEN BITE TREATMENT: LE FORT I VERSUS 4-PIECE SEGMENTAL LE FORT I OSTEOTOMY

Abstract

Introduction: This study aims to test the null hypothesis that there is no difference in the long-term stability of the surgical correction of anterior open bite when comparing Le Fort I to 4-piece segmental Le Fort I osteotomies. **Methods:** Lateral cephs of 29 open-bite subjects treated with 1-piece Lefort I osteotomy were compared to the lateral cephs of 24 open-bite subjects treated with 4-piece Lefort I osteotomy. Class I, Class II, and Class III subjects were included. The groups were matched regarding age and were compared with t-tests and chi-square tests. **Results:** In the 1-piece Le Fort I group 65.52% of patients presented with clinically significant overbite stability, while in the 4-piece group 83.33% remained stable in the long-term. **Conclusions:** Despite the higher clinically significant overbite stability percentage on 4-piece Le Fort I group than in 1-piece Le Fort I group, the null hypothesis was accepted because it was not statistically significant. Moreover, the type of fixation seems to influence overbite stability more than the type of maxillary segmentation.

INTRODUCTION

Skeletal anterior open bite often requires surgical correction due to the extreme hyper divergency between the bone bases and its impact on occlusion, phonation, and esthetics, regardless of the severity of this vertical malocclusion.¹⁻⁴ The difficulties of treatment and low stability in cases of anterior open bite, even in surgically treated cases, can lead patients and professionals to frustration.^{3,5}

The advancement and development of new surgical techniques can, in theory, bring greater stability in the long-term when treating this challenging malocclusion.⁶ The most severe skeletal discrepancies in anterior open bite malocclusion should be

corrected surgically, allowing an adequate maxillomandibular position and dentoalveolar interdigitation.⁷⁻¹¹

A variety of surgical techniques has been used to correct anterior open bite.^{8,11-13} Le Fort I impaction approach often requires the prior execution of surgically assisted rapid maxillary expansion (SARME). Another option is the multi-segmented Le Fort I osteotomy^{10,14}, allowing the impaction of the maxilla associated with its advance simultaneously correcting transversal, vertical and anteroposterior discrepancies. In general, segmentation is indicated when there are transversal impairments. Particularly in open bites, the presence of a 2-step maxillary occlusal plane is a chief-factor to choose the segmental approach. There is no consensus in the literature regarding the long-term stability when these two approaches are compared in the treatment of skeletal open bites.^{12,15}

There are few consistent and specific studies evaluating the long-term stability of anterior open bite surgical correction⁸. Some literature reviews¹⁶, systematic reviews¹⁷, and even meta-analyses^{5,18} were made over the last decade, highlighting the lack of well-designed studies with proper sample sizes and adequate long-term follow-up period to establish a reliable, evidence-based status of the stability of the surgical approach when treating open bites. The main problems found in the available studies are related to small sample size, the absence of method error assessment, sample heterogeneity and absence of initial records.^{17,19}

Therefore it is of paramount importance to the orthodontist and to the oral surgeon as well, to know if any difference exists regarding the long-term over bite behavior when different surgical approaches are employed in open bite malocclusion surgical-orthodontic treatment.

The purposes of this study are 1- To test the null hypothesis that there is no difference in the long-term stability of the surgical correction of anterior open bite when comparing Le Fort I (1-piece) to Segmental Le Fort I (4-piece) osteotomies. 2- Evaluate skeletal and dentoalveolar changes that can influence open bite relapse.

MATERIAL AND METHODS

This study was submitted to and approved by the institutional review board of Bauru Dental School, University of Sao Paulo, Brazil, under the protocol number: CAAE 71636716.5.0000.5417.

Sample size calculation, considering an 80% test power at a significance level of 5%, with a minimum mean difference to be detected of 1.2 mm and a mean standard deviation of 1.45 mm, showed that 24 subjects in each of the two groups were the minimum for providing reliable results. The minimum mean difference to be detected and the standard deviation of the variable overbite relapse were based on a previous study.¹³

Inclusion criteria comprised: initial anterior open-bite malocclusion of at least 1mm, treated orthodontically and surgically with 1-piece Le Fort I or 4-piece Le Fort I osteotomies, no previous orthodontic treatment; positive overbite after treatment; comparable retention protocols; facial trauma absence; buccofacial pathology absence, genetic syndromes/ congenital deformities absence;

Lateral cephs were taken at three stages: pretreatment (T1), posttreatment (T2 – immediately after debonding), and long-term follow-up (T3 - at least two years after debonding). The presurgical orthodontic treatment comprised leveling and alignment with fixed preadjusted appliances. Intermaxillary fixation with elastics was indicated in the postsurgical phases during seven weeks. Seven different professional teams treated patients. Regarding retention protocol, a Hawley retainer was recommended during the first 12 posttreatment months, and a canine-to-canine retainer to control the mandibular incisor alignment for a mean period of 2 years. Open bite relapse was considered as a negative overbite showed at T3. Only six patients presented with TMD symptoms and three required TMJ disc repositioning.^{20,21}

The sample was divided into two groups:

Group 1: 1-piece Le Fort I comprised 29 patients (11 male, 18 female) with a mean age of 23.22 years (ranging from 16.83 years to 37.91 years). Regarding anteroposterior discrepancy, this group presented 4 Class I, 12 Class II and 13 Class III patients. In only 6 patients orthognathic surgery was restricted to the maxilla, while the remaining 23 patients were treated by combining 1-piece Le Fort I to BSSO

(Bilateral Sagittal Split Osteotomy). Surgical fixation with intraosseous wires (WF) was performed in 17 patients (58.62%), and 12 (41.38%) received rigid internal fixation. Patients in this group were treated by the same professional team, including only two surgeons. The posttreatment follow-up had a mean time of 7.74 years (ranging from 2 years to 18.83 years). Due to the presence of two different types of bone fixation (Wires and RIF) in Group 1 and the possible influence that it could have in the long-term stability,²² this group was divided into two subgroups, described as follows:

Subgroup 1 (WF): comprising 17 patients (5 male, 12 female) with a mean age of 22.50 years (ranging from 16.83 years to 37.91 years). Regarding anteroposterior discrepancy, this group presented 3 Class I, 8 Class II and 6 Class III patients. In 4 patients, orthognathic surgery was restricted to the maxilla, while the remaining 13 patients were treated by combining 1-piece Le Fort I to BSSO (Bilateral Sagittal Split Osteotomy). Patients in this group were treated by the same professional team, including only two surgeons. The posttreatment follow-up interval had a mean time of 10.65 years (ranging from 4 years to 18.83 years).

Subgroup 2 (RIF): comprising 12 patients (6 male, 6 female) with a mean age of 24.25 years (ranging from 14.83 years to 37.91 years). Regarding anteroposterior discrepancy, this group presented 1 Class I, 4 Class II and 7 Class III patients. In 2 patients, orthognathic surgery was restricted to the maxilla, while the remaining 10 patients were treated by combining 1-piece Le Fort I to BSSO (Bilateral Sagittal Split Osteotomy). Patients in this group were treated by the same professional team, including only two surgeons. The posttreatment follow-up interval had a mean time of 3.61 years (ranging from 2 years to 6.84 years).

Group 2: 4-piece Le fort I group comprised 24 patients (16 male, eight female) with a mean age of 26.30 years (ranging from 14.83 years to 48.66 years). Regarding anteroposterior discrepancy, this group presented 3 Class I, 9 Class II and 12 Class III patients. In only 2 patients orthognathic surgery was restricted to the maxilla, while the remaining 22 patients were treated by combining 4-piece Le Fort I to BSSO (Bilateral Sagittal Split Osteotomy). Surgical fixation with rigid internal fixation (RIF) was performed in all patients in this group. Patients in this group were treated by 5 different professional teams, including 5 surgeons, as described: surgeon # 1(3 patients), surgeon # 2 (7 patients), surgeon # 3 (6 patients), surgeon #

4 (4 patients) and surgeon # 5 (4 patients). Retention included a maxillary Hawley plate during the first posttreatment year and a bonded mandibular canine-to-canine retainer for a mean period of 2 years. The posttreatment follow-up had a mean time of 3.71 years (ranging from 2 years to 16.75 years).

Methods

Lateral cephs of each patient were obtained at T1, T2, and T3, and due to a long time passed between patient recalls, several x-ray machines and magnification factors were present, varying from 6% to 11.6%. Cephalometric tracings and magnification adjustment were performed by using Dolphin® Imaging 11.0 (Dolphin Imaging and Management Solutions, Chatsworth, Calif., EUA).

In total, 23 measurements (11 angulars, 12 linear), divided between the maxillary component, mandibular component, maxillomandibular relationship, growth pattern, maxillary dentoalveolar component, mandibular dentoalveolar component and dental relationships were performed (Table I) to evaluate skeletal and dentoalveolar features.

Error study

Error study assessment comprised 32 of the 159 Lateral cephs which were randomly selected and measured again, by the same operator (VLBS), after a minimum 30-day interval. Random errors were calculated according to Dahlberg's formula ($Se2 = \sum d^2/2n$),²³ and the systematic errors with dependent t-tests, at $P < 0.05$.²⁴⁻²⁶

Statistical analyses

To assess normal distribution of data in the sample, Kolmogorov-Smirnov tests were performed. All variables showed normal distributions in the two groups.

Chi-square test was used to compare the groups regarding sex distribution, and the percentages of patients with clinically significant stability/relapse in each group and subgroups.

T-tests were used to evaluate the intergroup comparability of age, and all variables at T1, T2-T1, T2, T3-T2, and T3. Posttreatment time of those subjects that presented overbite clinical stability was compared to those who relapsed in Group 1 (1-piece) by using t-tests.

Results were considered significant at $P < 0.05$. All statistical analyses were performed with Statistica software (Statistica for Windows 10.0; StatSoft, Tulsa, Okla.).

RESULTS

Three variables presented with significant systematic error (Mx1.SN; Mx1-NA; Interincisal angle), requiring caution when taking these measurements into account. Random errors varied within acceptable limits from 0.20mm (overbite) to 3.28mm (CoA).²⁵ Sex distribution presented a statistically significant difference between groups at T1 (Table II).

Group 1 (1-piece) x Group 2 (4-piece):

Group 1 (1-piece) presented longer treatment and posttreatment times than Group 2 (4-piece) at T1 (Table III) significantly.

Treatment changes results showed, in both groups, that A-Nperp (mm), SNB angle and Inter-incisal angle increased with treatment, but to a lesser extent in Group 1(1-piece) than in Group 2 (4-piece) (Table IV). FMA, SNGoGn, and Md1-Apo (mm) decreased with treatment, in both groups, but to a lesser extent in Group 1(1-piece) than in Group 2 (4-piece) (Table IV). Md1-MP (mm) and Md6-MP (mm) measurements increased in Group 1(1-piece) while decreased in Group 2 (4-piece) (Table IV).

At the end of treatment, IMPA, ANB, and overjet presented higher values in Group 1(1-piece) than in Group 2 (4-piece) at T2 (Table V). Inter-incisal angle presented smaller value in Group 1(1-piece) than in Group 2 (4-piece) at T2 (Table V).

Posttreatment changes were similar between groups.

After follow-up, IMPA, ANB, and Md6-MP (mm) presented greater values in Group 1(1-piece) than in Group 2 (4-piece) at T3 (Table VII). Mx1-NA, and inter-incisal angle presented positive smaller values in Group 1(1-piece) than in Group 2 (4-piece) at T3 (Table VII).

Overbite behavior

Overbite remained positive at T3. Group 1 (1-piece) presented a smaller positive and statistically significant mean of 0.14 mm than Group 2 (4-piece) which was 1mm at T3. Although the difference in overbite mean, stability percentages were not statistically significant different: Group 1 (1-piece) 65.52% and Group 2 (4-piece) 83.33%.

Subgroup 1 (WF) x Group 2 (4-piece)

Regarding treatment time and posttreatment time duration, Subgroup 1(WF) presented a significantly longer period than Group 2 (4-piece) at T1 (Table VIII).

Treatment changes results showed, in both groups, that SNA, A-Nperp (mm), Inter-incisal angle increased with treatment, but to a lesser extent in Subgroup 1(WF) than in Group 2 (4-piece) (Table IX). FMA and SNGoGn decreased with treatment, but to a lesser extent in Subgroup 1(WF) than in Group 2 (4-piece) (Table IX). Md1-MP (mm) and Md6-MP (mm) measurements increased with treatment in Subgroup 1(WF) while decreased in Group 2 (4-piece) (Table IX).

At the end of treatment, IMPA, ANB, FMA, and Md1-Apo (mm) presented higher values in Subgroup 1(WF) than in Group 2 (4-piece) at T2 (Table X). Inter-incisal angle presented smaller value in Subgroup 1(WF) than in Group 2 (4-piece) at T2 (Table X).

Posttreatment changes were similar between groups.

After follow-up, ANB and FMA presented greater in Subgroup 1(WF) than in Group 2 (4-piece) at T3 (Table XII). Pog-NB (mm), Mx1-NA (mm) and inter-incisal angle presented smaller values in Subgroup 1(WF) than in Group 2 (4-piece) at T3 (Table XII).

Overbite behavior

Overbite returned to a negative mean only in Subgroup 1 (WF) at T3. Subgroup 1 (WF) presented a negative and statistically significant mean of -0.18 mm than Group 2 (4-piece) which was 1mm at T3. Moreover, clinical stability percentage in Subgroup 1 (WF) (52.94%) was also statistically significant smaller than Group 2 (4-piece) (83.33%) (Table XII).

Subgroup 2 (RIF) x Group 2 (4-piece):

Regarding treatment time duration, Subgroup 2 (RIF) presented a significantly longer period than Group 2 (4-piece) at T1 (Table XIII).

Treatment changes results showed, in both groups, that FMA, MP-SN, and Md1-APo decreased with treatment, but to a lesser extent in Subgroup 2 (RIF) than in Group 2 (4-piece) (Table XIV). SN-PP, SN-OP, Md1-MP (mm) and Md6-MP (mm) measurements increased with treatment in Subgroup 2 (RIF) while decreased in Group 2 (4-piece) (Table XIV).

At the end of treatment, Mx6-PTV (mm) presented higher value in Subgroup 2 (RIF) than in Group 2 (4-piece) at T2 (Table XV). Inter-incisal angle presented smaller value in Subgroup 2 (RIF) than in Group 2 (4-piece) at T2 (Table XV).

Posttreatment changes were similar between groups.

After follow-up, IMPA presented higher value in Subgroup 2 (RIF) than in Group 2 (4-piece) at T3 (Table XVII). Inter-incisal angle presented smaller value in Subgroup 2 (RIF) than in Group 2 (4-piece) at T3 (Table XVII).

Overbite behavior

Overbite remained positive at T3 in Subgroup 2 (RIF), with a mean of 0.60 mm and in Group 2 (4-piece) it was 1 mm. Besides, clinical stability percentages were the same in both groups (83.33%) (Table XVII).

Posttreatment time comparison in Group 1 (1-piece)

Posttreatment time comparison of those subjects who remained clinically stable to those who relapsed showed no statistically significant difference (Table XVIII).

DISCUSSION**Sample**

The groups were not comparable regarding sex distribution. However, this is not a problem since overbite behavior shows no difference between sexes.^{27,28} Our sample comprises a considerable number of specific open bite subjects distributed

among groups and subgroups, while other studies had not that degree of specification.^{29,30} Such characteristic, allows the isolation of long-term stability potential influencing factors, such as maxillary segmentation, type of fixation, anteroposterior discrepancy, and operator bias with a proper number of individuals. Besides, at T1, mostly initial records were included, in spite of pre-surgical ones,^{12,31} this is important because the initial open bite severity must be measured, avoiding the possible influence of pre-surgical orthodontics (posterior tooth intrusion/anterior tooth extrusion). According to most authors,^{4,32-34} orthodontic preparation can influence post-surgical stability, while others disagree.^{35,36} Due to the variability in the duration of post-surgical orthodontic treatment and the influence of the use of intermaxillary anterior elastics exerts on overbite maintenance, a mean long-term follow-up of 5.92 years after appliance removal and not immediately after surgery, as we find in some studies,^{12,31} is also a strong feature present in this sample.

Operator bias (number and expertise of professionals) is regarded as a factor which could influence treatment outcome when surgical procedures are assessed, however just a few studies really evaluated this condition. According to this rationale, in our study, Group 1 (1-piece), which presented more homogeneity on this issue (only two oral surgeons), should demonstrate higher rates of stability than in Group 2 (4-piece), comprising five different oral surgeons. Thus our results contradict this tendency. The expertise of the operators is more important than the number of professionals involved in the research.³⁷ Despite a considerable high number of different professionals have participated in the sample, only experienced orthodontists and oral surgeons with academic background conducted all treatments. Again, is imperative to highlight the difficulty of retrospectively select a sample with such specific characteristics. Moreover, this diversity regarding operators can show us a more realistic Prisma on the long-term stability of surgical-orthodontic open bite treatment, since data was collected in private practices across the country.

Another characteristic of our sample that could have influenced the results is that the patients in Group 1 (1-piece) presented a statistically significant greater mean in the posttreatment time of 7.74 years, than Group 2 (4-piece) which was 3.71 years (Table III). This fact, give us the chance to speculate that, based on the literature,^{9,38} the patients in Group 2 (4-piece) have a higher chance of relapse over time than those in Group 1 (1-piece) because the posttreatment time was less than

five years. Moreover, if we take a closer look at the posttreatment time of those subjects who relapsed in Group 1 (1-piece), we found an increase in the mean to 9.01 years when compared to the whole Group 1 (1-piece) mean which was 7.74 years. Conversely, looking at those in Group 1 (1-piece) who remained stable we found a mean of 7.07 years, which is closer to the whole Group 1 (1-piece) mean which was 7.74 years (Table XVIII). However, there was no statistically significant difference when the posttreatment times of those patients who relapsed were compared to those who remained stable in Group 1 (1-piece) (Table XVIII). In Group 2 (4-piece), contrary to the results of Group 1 (1-piece), the relapsed subjects had a smaller posttreatment time of 2.64 years than the whole Group 2 (4-piece) mean which was 3.71 years. Whereas the stable ones presented with a greater mean value of 4.87 years, no statistically significant difference was detected (Table XVIII). So, the available data does not allow us to clarify this speculation. Hence, specific studies about this issue should be performed to assess this tendency.

Treatment changes regarding growth pattern measurements (FMA and SN.GoGn) and SNB were smaller in Group 1(1-piece) than in Group 2 (4-piece) (Table IV), hence the relapse tendency should be lesser in Group 1 (1-piece) than in Group 2 (4-piece), however, the posttreatment phase was similar between groups (Table VI).

Overbite stability

Due to the variability of results found in previous studies,^{9,29,31,35,39,40} the main objective of this study was to compare the long-term clinical stability/relapse of surgical-orthodontic treatment in a specific sample of open bite patients between two different surgical approaches. Regarding the skeletal stability, some authors concluded that no difference was found on the vertical plane between 1-piece Le Fort I and 3-piece Le Fort I osteotomies.^{7,35,39} While others, considering the final overbite result regardless of what led to the overbite stability/instability, found that 1-piece was more stable^{31,41} and some others considered 1-piece less stable than segmental ones such as 3-piece.^{12,19,29}

Our results, although demonstrated a statistically significant greater overbite value of 1mm at T3 (Table VII) in Group 2 (4-piece) than in Group 1 (1-piece) which was 0.06mm, showed that overbite means in both groups remained positive after

follow-up. When the percentages of stable subjects are observed, despite the higher stability percentage in Group 2 (83.33%) than in Group 1 (65.52%), results were not statistically significant (Table VII). In Group 1 (1-piece), 19 out of 29 patients remained clinically stable (overbite greater than 0mm) and 10 presented with a clinically overbite relapse (overbite measurement smaller than 0mm), whereas 20 out of 24 patients remained clinically stable (overbite greater than 0mm) after the long-term observation period and 4 presented with a clinical overbite relapse (overbite measurement smaller than 0mm) in Group 2 (4-piece) (Table VII).

Because in Group 2 (4-piece) all patients received R.I.F whereas in Group 1 (1-piece) patients were treated with different types of fixation (intra-osseous wires/rigid internal fixation) and there is strong evidence that it can influence long-term stability of surgical procedures,⁷ Group 1 (1-piece) was divided into two subgroups (Subgroup 1 (WF) and Subgroup 2 (RIF)). The Subgroup 1 (WF) to Group 2 (4-piece) comparison produced quite different results. Nine out of 17 patients remained clinically stable (overbite greater than 0mm) after the long-term observation period and 8 presented with a clinical overbite relapse (overbite measurement smaller than 0mm). Overbite mean in Subgroup 1 (WF) became negative after follow-up (-0.14mm), increasing the existing statistically significant difference in the overbite at T3 (Table XII). Moreover, regarding the percentages of stable subjects in Subgroup 1 (WF), it dropped to 52.94% turning the difference statistically significant (Table XII).

The Subgroup 2 (RIF) to Group 2 (4-piece) comparison indicated that the type of fixation exerts an influence on the long-term stability of open bite surgical-orthodontic correction corroborating other investigations.^{2,4,7} Both groups presented positive and similar overbite means (Subgroup 2 (0.35mm) and Group 2 (1mm)) at T3 (Table XVII). The percentage of clinically stable overbite was the same in both groups (83.33%) hence results were not statistically significant (Table XVII). Ten out of 12 patients remained clinically stable (overbite greater than 0mm) after the long-term observation period and only 2 presented with a clinical overbite relapse (overbite measurement smaller than 0mm) (Table XVII).

Posttreatment changes were similar among all groups and subgroups, however, in the Subgroup 1 (WF) to Group 2 (4-piece) comparison, a stronger tendency in overbite decrease in Group 1 (-0.92mm) was observed compared to

Group 2 (-0.10mm) with a $p=0.095$ (Table XI). Even though, Subgroup 2 (RIF) has only 12 patients whereas Group 2 (4-piece) has 24, they presented very similar results in all treatment phases, mainly in the posttreatment follow-up (Tables XII to XVII), revealing the strong influence of the type of fixation in the overall results of Group 1 (1-piece).

CONCLUSIONS

The null hypothesis was accepted because:

- There was no significant intergroup difference regarding the percentage of clinically stable patients;
- The type of fixation seems to influence the long-term stability of open bite surgical-orthodontic correction more than maxillary segmentation.

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Table I. Cephalometric variables description.

Maxillary component
1. SNA angle (°) SN to NA.
2. Co-A (mm) Condylion to A-point.
3. A-Nperp (mm) A-point to nasion-perpendicular.
Mandibular component
4. SNB angle (°) SN to NB.
5. IMPA (°) Incisor mandibular plane angle
6. Pog-NB (mm) Pogonion to NB
7. GoGn.OP(°) Mandibular plane to occlusal plane
Maxillomandibular relationship
8. ANB angle (°) NA to NB.
9. Wits appraisal (mm) Distance between perpendicular projections of Points A and B on the functional occlusal plane (plane drawn through points of occlusal contact between the first permanent molars and the first and second premolars).
Growth pattern
10. FMA (°) Frankfort mandibular plane angle.
11. SN.GoGn (°) SN to GoGn angle.
12. SN.PP (°) SN to palatal plane angle.
13. SN.OP (°) SN to functional occlusal plane angle.
Maxillary dentoalveolar component
14. Mx1.SN (°) Angle between maxillary incisor long axis and SN
15. Mx1-NA (mm) Distance from incisal edge of maxillary incisor to NA
16. Mx1Tip-VRP (mm) Distance from incisal edge of maxillary incisor to SN
17. Mx6-PTV (mm) Distance from mesial cusp of maxillary first molar to PTV
Mandibular dentoalveolar component
18. Md1-MP (mm) Perpendicular distance between incisal edge of mandibular incisor and mandibular plane.
19. Md6-MP (mm) Perpendicular distance between mesial cusp of mandibular first molar and mandibular plane.
20. Md1-Pogperp (mm) Perpendicular distance between incisal edge of mandibular central incisor and Pogperp (line perpendicular to mandibular plane, passing through pogonion).
Dental relationships
21. Overbite (mm) Distance between incisal edges of maxillary and mandibular central incisors, perpendicular to functional occlusal plane.
22. Overjet (mm) Distance between incisal edges of maxillary and mandibular central incisors, parallel to functional occlusal plane.
23. Interincisal angle (°) Angle between the intersection of maxillary and mandibular incisors long axis

Table II. Intergroup comparability regarding sex (chi-square).

Sex Group	Male	Female	Total
G1(1-piece)	11	18	29
G2(4-piece)	16	8	24
Total	27	26	53
P= 0.000*			

*Statistically significant at $P<0.05$

Table III. Group 1 (1-Piece) to Group 2 (4-piece) comparability regarding age, treatment time, posttreatment time and cephalometric variables at T1 (t test).

Variables	Group 1 (1-Piece) (N=29)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Age (y)	23.22	5.79	26.30	9.92	0.164
Treatment time (y)	3.54	2.56	1.27	1.23	0.000*
Posttreatment time (y)	7.74	4.55	3.71	3.20	0.000*
Sex					
Maxillary component					
SNA (°)	82.64	4.67	78.17	5.63	0.002*
CoA (mm)	80.06	3.86	77.80	8.61	0.210
A-Nperp (mm)	1.92	4.42	-0.58	4.06	0.038*
Mandibular component					
SNB (°)	78.93	5.49	76.52	7.95	0.198
IMPA(°)	87.89	9.55	84.09	7.54	0.119
Pog-NB (mm)	1.37	1.73	1.76	1.89	0.438
GoGn.OP(°)	23.53	4.93	25.70	6.73	0.182
Maxillomandibular relationship					
ANB (°)	3.71	5.93	1.70	5.33	0.205
Wits appraisal (mm)	-1.59	8.05	-2.36	6.87	0.711
Growth pattern					
FMA(°)	31.35	4.90	32.90	10.07	0.468
SN.GoGn(°)	40.82	5.82	44.22	11.48	0.169
SN.PP(°)	-0.50	3.48	0.29	4.36	0.459
SN.OP(°)	17.28	4.42	18.52	7.67	0.464
Maxillary dentoalveolar component					
Mx1.SN (°)	107.94	7.59	106.66	9.21	0.583
Mx1-NA (mm)	4.83	3.36	6.65	3.16	0.048*
Mx1Tip-VRP (mm)	69.25	6.97	65.67	10.78	0.150
Mx6-PTV (mm)	21.50	5.28	21.14	5.82	0.813
Mandibular dentoalveolar component					
Md1-MP (mm)	39.76	3.97	40.35	4.64	0.623
Md6-MP (mm)	31.25	3.54	31.57	4.03	0.760
Md1-Apo (mm)	4.30	2.79	4.81	2.41	0.485
Dental relationships					
Overbite (mm)	-3.27	1.66	-3.68	2.39	0.474
Overjet (mm)	2.72	4.94	2.23	4.66	0.711
Interincisal angle (°)	123.35	13.04	125.01	10.12	0.611

*Statistically significant at $P<0.05$

Table IV. Treatment changes comparison between Group 1 (1-Piece) and Group 2 (4-piece) from T2 to T1 (t test).

Variables	Group 1 (1-Piece) (N=29)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	2.37	4.82	4.75	3.64	0.052
CoA (mm)	2.76	4.94	3.85	8.62	0.567
A-Nperp (mm)	1.55	4.32	3.83	2.96	0.032*
Mandibular component					
SNB (°)	1.75	3.60	4.29	4.10	0.020*
IMPA (°)	0.99	7.38	-0.05	5.77	0.574
Pog-NB (mm)	1.99	2.37	2.52	3.02	0.476
GoGn.OP(°)	-2.80	5.25	-4.18	4.86	0.327
Maxillomandibular relationship					
ANB (°)	0.62	3.65	0.41	4.72	0.857
Wits appraisal (mm)	-0.67	6.88	-0.08	5.23	0.730
Growth pattern					
FMA(°)	-2.13	4.69	-6.81	5.59	0.001*
SN.GoGn(°)	-2.80	5.24	-7.42	5.38	0.002*
SN.PP(°)	0.07	4.25	-2.49	5.21	0.053
SN.OP(°)	0.01	5.98	-3.25	5.72	0.050
Maxillary dentoalveolar component					
Mx1.SN (°)	-2.03	7.51	-2.23	5.87	0.917
Mx1-NA (mm)	-1.14	3.75	-1.68	3.42	0.590
Mx1Tip-VRP (mm)	2.63	4.13	3.99	8.26	0.440
Mx6-PTV (mm)	3.11	5.38	3.86	4.19	0.580
Mandibular dentoalveolar component					
Md1-MP (mm)	2.18	3.41	-1.04	3.01	0.000*
Md6-MP (mm)	1.33	3.46	-1.62	3.29	0.002*
Md1-Apo (mm)	-0.56	3.69	-2.50	2.51	0.033*
Dental relationships					
Overbite (mm)	4.22	1.90	4.84	2.21	0.280
Overjet (mm)	-0.39	5.08	0.62	4.71	0.456
Interincisal angle (°)	3.84	10.05	9.73	7.04	0.019*

*Statistically significant at $P<0.05$

Table V. Group 1 (1-Piece) to Group 2 (4-piece) comparison regarding cephalometric variables at T2 (t test).

Variables	Group 1 (1-Piece) (N=29)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	85.02	4.25	83.13	6.22	0.196
CoA (mm)	82.83	6.12	81.64	10.81	0.618
A-Nperp (mm)	3.47	4.01	3.30	4.01	0.880
Mandibular component					
SNB (°)	80.69	5.39	80.92	5.52	0.880
IMPA (°)	88.88	9.08	83.65	6.55	0.022*
Pog-NB (mm)	3.36	2.42	4.27	2.33	0.173
GoGn.OP(°)	20.73	4.64	21.80	5.88	0.464
Maxillomandibular relationship					
ANB (°)	4.33	3.95	2.21	2.53	0.028*
Wits appraisal (mm)	-2.26	3.59	-2.88	3.95	0.553
Growth pattern					
FMA(°)	29.22	5.11	27.05	6.71	0.187
SN.GoGn(°)	38.02	6.41	37.61	8.71	0.846
SN.PP(°)	-0.43	4.28	-1.94	5.19	0.251
SN.OP(°)	17.27	6.32	15.80	6.20	0.398
Maxillary dentoalveolar component					
Mx1.SN (°)	105.90	8.93	104.10	7.53	0.438
Mx1-NA (mm)	3.68	3.94	5.02	2.39	0.152
Mx1Tip-VRP (mm)	71.88	7.21	70.15	11.64	0.510
Mx6-PTV (mm)	24.62	5.48	24.72	5.38	0.947
Mandibular dentoalveolar component					
Md1-MP (mm)	41.95	4.41	39.65	5.45	0.096
Md6-MP (mm)	32.58	4.32	30.07	5.32	0.063
Md1-Apo (mm)	3.73	2.67	2.51	1.96	0.068
Dental relationships					
Overbite (mm)	0.94	0.58	1.08	0.72	0.432
Overjet (mm)	2.33	0.61	2.82	1.04	0.040*
Interincisal angle (°)	127.19	8.74	134.63	7.62	0.001*

*Statistically significant at $P<0.05$

Table VI. Posttreatment changes comparison between Group 1 (1-Piece) and Group 2 (4-piece) from T3 to T2 (t test).

Variables	Group 1 (1-Piece) (N=29)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	0.17	2.98	-0.19	3.33	0.670
CoA (mm)	2.68	3.29	0.41	8.25	0.179
A-Nperp (mm)	-0.15	2.61	-0.09	2.55	0.938
Mandibular component					
SNB (°)	-0.46	2.25	-0.22	2.79	0.725
IMPA (°)	0.83	4.88	0.42	3.62	0.732
Pog-NB (mm)	-0.07	0.79	-0.07	1.10	0.996
GoGn.OP(°)	0.80	3.20	0.06	2.91	0.389
Maxillomandibular relationship					
ANB (°)	0.63	2.20	0.02	1.76	0.275
Wits appraisal (mm)	1.02	3.02	-0.45	2.95	0.080
Growth pattern					
FMA(°)	0.97	3.17	0.64	2.27	0.675
SN.GoGn(°)	0.64	3.29	0.59	3.14	0.955
SN.PP(°)	-0.53	2.51	0.55	3.72	0.213
SN.OP(°)	-0.15	2.19	0.54	4.08	0.429
Maxillary dentoalveolar component					
Mx1.SN (°)	0.15	4.77	-0.65	5.00	0.554
Mx1-NA (mm)	-0.53	2.54	-0.32	2.35	0.750
Mx1Tip-VRP (mm)	1.35	2.74	0.63	8.25	0.658
Mx6-PTV (mm)	1.00	2.92	0.04	3.65	0.290
Mandibular dentoalveolar component					
Md1-MP (mm)	0.44	1.31	0.52	3.48	0.908
Md6-MP (mm)	0.68	1.43	0.66	3.41	0.973
Md1-Apo (mm)	-0.08	1.69	0.11	1.20	0.632
Dental relationships					
Overbite (mm)	-0.88	1.66	-0.09	1.25	0.062
Overjet (mm)	0.22	1.93	-0.43	1.30	0.162
Interincisal angle (°)	-1.63	6.68	-0.36	5.69	0.464

Table VII. Group 1 (1-Piece) to Group 2 (4-piece) comparison of cephalometric variables at T3 (t test) and percentages of patients presenting with clinically significant open bite relapse between groups (chi-square test).

Variables	Group 1 (1-Piece) (N=29)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	85.21	4.35	82.77	6.40	0.106
CoA (mm)	85.48	5.86	82.73	9.34	0.198
A-Nperp (mm)	3.29	3.07	3.09	4.80	0.851
Mandibular component					
SNB (°)	80.30	5.76	80.86	6.06	0.734
IMPA (°)	89.70	8.92	84.14	6.16	0.012*
Pog-NB (mm)	3.30	2.48	4.24	2.06	0.143
GoGn.OP(°)	21.40	5.31	21.84	5.12	0.760
Maxillomandibular relationship					
ANB (°)	4.90	4.48	1.90	2.51	0.005*
Wits appraisal (mm)	-1.40	4.47	-3.09	3.53	0.137
Growth pattern					
FMA(°)	30.14	6.02	26.80	7.33	0.074
SN.GoGn(°)	38.56	7.46	37.32	8.16	0.565
SN.PP(°)	-1.07	3.36	-1.73	5.21	0.577
SN.OP(°)	17.16	5.92	15.48	6.24	0.322
Maxillary dentoalveolar component					
Mx1.SN (°)	106.16	8.61	104.4	9.55	0.484
Mx1-NA (mm)	3.18	3.07	4.87	2.15	0.027*
Mx1Tip-VRP (mm)	73.22	7.36	71.02	11.69	0.408
Mx6-PTV (mm)	25.66	5.29	24.99	6.04	0.668
Mandibular dentoalveolar component					
Md1-MP (mm)	42.39	4.79	40.07	4.42	0.075
Md6-MP (mm)	33.24	4.81	30.64	4.50	0.049*
Md1-Apo (mm)	3.65	2.68	2.54	1.83	0.089
Dental relationships					
Overbite (mm)	0.14	1.61	1.00	1.21	0.036*
Overjet (mm)	2.53	1.82	2.35	1.11	0.679
Interincisal angle (°)	125.56	11.47	134.15	8.13	0.003*
Clinically significant stability/relapse	Stability	Relapse	Stability	Relapse	0.143¥
Percentage of patients(%)	65.52%	34.48%	83.33%	16.67%	
Number of patients	n=19	n=10	n=20	n=4	

*Statistically significant at $P < 0.05$

¥chi-square

Table VIII. Subgroup 1 (WF) to Group 2 comparability regarding age, treatment time, posttreatment time and cephalometric variables at T1 (t test).

Variables	Subgroup1(WF) (1-Piece) (N=17)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Age (y)	22.50	3.96	26.30	9.92	0.142
Treatment time (y)	3.20	2.42	1.27	1.23	0.001*
Posttreatment time (y)	10.65	3.62	3.71	3.20	0.000*
Maxillary component					
SNA (°)	82.84	4.95	78.17	5.63	0.009*
CoA (mm)	80.55	4.31	77.80	8.61	0.232
A-Nperp (mm)	2.52	4.53	-0.58	4.11	0.027*
Mandibular component					
SNB (°)	77.71	5.52	76.52	7.95	0.595
IMPA (°)	87.97	9.76	84.09	7.54	0.159
Pog-NB (mm)	1.51	1.68	1.76	1.89	0.665
GoGn.OP(°)	22.92	4.07	25.70	6.73	0.138
Maxillomandibular relationship					
ANB (°)	5.12	6.24	1.70	5.33	0.066
Wits appraisal (mm)	-0.56	8.62	-2.36	6.87	0.461
Growth pattern					
FMA(°)	31.75	4.64	32.90	10.07	0.666
SN.GoGn(°)	41.68	5.36	44.22	11.48	0.402
SN.PP(°)	0.09	3.28	0.29	4.36	0.873
SN.OP(°)	18.75	4.70	18.52	7.67	0.911
Maxillary dentoalveolar component					
Mx1.SN (°)	105.40	6.03	106.66	9.21	0.624
Mx1-NA (mm)	3.78	2.81	6.65	3.16	0.004*
Mx1Tip-VRP (mm)	68.16	8.14	65.67	10.78	0.426
Mx6-PTV (mm)	20.95	4.66	21.14	5.82	0.915
Mandibular dentoalveolar component					
Md1-MP (mm)	39.38	4.11	40.35	4.64	0.493
Md6-MP (mm)	31.27	4.19	31.57	4.03	0.822
Md1-Apo (mm)	4.07	2.59	4.81	2.41	0.350
Dental relationships					
Overbite (mm)	-3.28	1.97	-3.68	2.39	0.580
Overjet (mm)	3.68	4.98	2.23	4.66	0.344
Interincisal angle (°)	124.94	13.65	125.01	10.12	0.985

*Statistically significant at $P < 0.05$

Table IX. Treatment changes comparison between Subgroup 1 (WF) to Group 2 (4-piece) from T2 to T1 (t test).

Variables	Subgroup1(WF) (1-Piece) (N=17)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	2.15	4.20	4.75	3.64	0.041*
CoA (mm)	1.71	4.06	3.85	8.62	0.347
A-Nperp (mm)	1.26	4.29	3.83	2.96	0.028*
Mandibular component					
SNB (°)	2.00	3.19	4.29	4.10	0.062
IMPA (°)	1.18	8.08	-0.05	5.77	0.572
Pog-NB (mm)	2.28	2.52	2.52	3.02	0.789
GoGn.OP(°)	-2.20	5.65	-4.18	4.86	0.236
Maxillomandibular relationship					
ANB (°)	0.17	3.74	0.41	4.72	0.861
Wits appraisal (mm)	-0.67	7.97	-0.08	5.23	0.775
Growth pattern					
FMA(°)	-2.22	5.27	-6.81	5.59	0.011*
SN.GoGn(°)	-3.05	5.68	-7.42	5.38	0.015*
SN.PP(°)	-1.42	3.73	-2.49	5.21	0.475
SN.OP(°)	-0.80	6.89	-3.25	5.72	0.221
Maxillary dentoalveolar component					
Mx1.SN (°)	-1.26	8.07	-2.23	5.87	0.658
Mx1-NA (mm)	-0.38	3.47	-1.68	3.42	0.242
Mx1Tip-VRP (mm)	2.47	4.23	3.99	8.26	0.492
Mx6-PTV (mm)	3.35	6.14	3.86	4.19	0.754
Mandibular dentoalveolar component					
Md1-MP (mm)	1.72	2.49	-1.04	3.01	0.003*
Md6-MP (mm)	0.84	3.01	-1.62	3.29	0.019*
Md1-Apo (mm)	-0.60	4.19	-2.50	2.51	0.077
Dental relationships					
Overbite (mm)	4.17	1.71	4.84	2.21	0.306
Overjet (mm)	-0.12	5.51	0.62	4.71	0.643
Interincisal angle (°)	3.11	9.88	9.73	7.04	0.016*

*Statistically significant at $P<0.05$

Table X. Subgroup 1 (WF) to Group 2 (4-piece) comparison regarding cephalometric variables at T2 (t test).

Variables	Subgroup1(WF) (1-Piece) (N=17)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	84.89	4.43	83.13	6.22	0.324
CoA (mm)	82.66	6.86	81.64	10.81	0.734
A-Nperp (mm)	3.17	4.31	3.30	4.01	0.919
Mandibular component					
SNB (°)	79.75	5.96	80.92	5.52	0.524
IMPA (°)	88.80	9.08	83.65	6.55	0.041*
Pog-NB (mm)	2.77	2.79	4.27	2.33	0.068
GoGn.OP(°)	21.12	3.71	21.80	5.88	0.676
Maxillomandibular relationship					
ANB (°)	5.13	4.37	2.21	2.53	0.010*
Wits appraisal (mm)	-1.95	4.09	-2.88	3.95	0.469
Growth pattern					
FMA(°)	31.15	4.61	27.05	6.71	0.035*
SN.GoGn(°)	39.73	6.88	37.61	8.71	0.409
SN.PP(°)	-0.61	4.63	-1,94	5.19	0.406
SN.OP(°)	18.60	6.33	15.80	6.20	0.166
Maxillary dentoalveolar component					
Mx1.SN (°)	104.82	8.97	104.10	7.53	0.783
Mx1-NA (mm)	3.12	3.83	5.02	2.39	0.057
Mx1Tip-VRP (mm)	70.60	8.41	70.15	11.64	0.894
Mx6-PTV (mm)	21.94	4.94	24.72	5.38	0.100
Mandibular dentoalveolar component					
Md1-MP (mm)	42.04	4.50	39.65	5.45	0.146
Md6-MP (mm)	32.40	4.02	30.07	5.32	0.136
Md1-Apo (mm)	4.00	2.72	2.51	1.96	0.048*
Dental relationships					
Overbite (mm)	1.04	0.65	1.08	0.72	0.836
Overjet (mm)	2.40	0.57	2.82	1.04	0.141
Interincisal angle (°)	126.64	9.17	134.63	7.62	0.004*

*Statistically significant at $P<0.05$

Table XI. Posttreatment changes comparison between Subgroup 1 (WF) and Group 2 (4-piece) from T3 to T2 (t test).

Variables	Subgroup1(WF) (1-Piece) (N=17)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	0.09	3.13	-0.19	3.33	0.779
CoA (mm)	3.67	3.34	0.41	8.25	0.133
A-Nperp (mm)	0.50	2.31	-0.09	2.55	0.445
Mandibular component					
SNB (°)	-0.74	2.19	-0.22	2.79	0.521
IMPA (°)	0.92	6.01	0.42	3.62	0.739
Pog-NB (mm)	-0.28	0.94	-0.07	1.10	0.532
GoGn.OP(°)	1.51	3.62	0.06	2.91	0.164
Maxillomandibular relationship					
ANB (°)	0.84	2.46	0.02	1.76	0.223
Wits appraisal (mm)	1.52	3.28	-0.45	2.95	0.050
Growth pattern					
FMA(°)	1.05	3.34	0.64	2.27	0.645
SN.GoGn(°)	1.45	3.60	0.59	3.14	0.418
SN.PP(°)	-0.12	2.09	0.55	3.72	0.505
SN.OP(°)	-0.04	2.26	0.54	4.08	0.595
Maxillary dentoalveolar component					
Mx1.SN (°)	-0.47	4.86	-0.65	5.00	0.909
Mx1-NA (mm)	-0.87	2.66	-0.32	2.35	0.484
Mx1Tip-VRP (mm)	1.35	2.94	0.63	8.25	0.731
Mx6-PTV (mm)	1.08	3.33	0.04	3.65	0.358
Mandibular dentoalveolar component					
Md1-MP (mm)	0.67	1.37	0.52	3.48	0.869
Md6-MP (mm)	0.56	1.65	0.66	3.41	0.909
Md1-Apo (mm)	-0.04	1.99	0.11	1.20	0.761
Dental relationships					
Overbite (mm)	-0.92	1.84	-0.09	1.25	0.095
Overjet (mm)	0.12	2.26	-0.43	1.30	0.325
Interincisal angle (°)	-1.94	8.33	-0.36	5.69	0.476

Table XII. Subgroup 1 (WF) to Group 2 (4-piece) comparison of cephalometric variables at T3 (t test) and percentages of patients presenting with clinically significant open bite relapse between groups (chi-square test).

Variables	Subgroup1(WF) (1-Piece) (N=17)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	84.99	4.65	82.77	6.40	0.231
CoA (mm)	86.14	6.32	82.73	9.34	0.199
A-Nperp (mm)	3.17	2.95	3.09	4.80	0.948
Mandibular component					
SNB (°)	79.04	5.99	80.86	6.06	0.348
IMPA (°)	89.21	9.91	84.14	6.16	0.050
Pog-NB (mm)	2.71	2.74	4.24	2.06	0.048*
GoGn.OP(°)	22.42	4.70	21.84	5.12	0.713
Maxillomandibular relationship					
ANB (°)	5.94	4.87	1.90	2.51	0.001*
Wits appraisal (mm)	-0.60	5.02	-3.09	3.53	0.069
Growth pattern					
FMA(°)	32.34	5.60	26.80	7.33	0.012*
SN.GoGn(°)	40.85	7.45	37.32	8.16	0.165
SN.PP(°)	-1.46	3.29	-1.73	5.21	0.850
SN.OP(°)	18.41	5.32	15.48	6.24	0.124
Maxillary dentoalveolar component					
Mx1.SN (°)	104.79	8.14	104.40	9.55	0.892
Mx1-NA (mm)	2.16	3.11	4.87	2.15	0.002*
Mx1Tip-VRP (mm)	72.18	8.47	71.02	11.69	0.727
Mx6-PTV (mm)	23.54	5.06	24.99	6.04	0.423
Mandibular dentoalveolar component					
Md1-MP (mm)	42.64	4.67	40.07	4.42	0.081
Md6-MP (mm)	33.21	4.62	30.64	4.50	0.082
Md1-Apo (mm)	3.80	3.14	2.54	1.83	0.114
Dental relationships					
Overbite (mm)	-0.18	1.87	1.00	1.21	0.018*
Overjet (mm)	2.52	2.23	2.35	1.11	0.750
Interincisal angle (°)	125.14	13.27	134.15	8.13	0.010*
Clinically significant relapse Percentage of patients (%) Number of patients	Stability 52.94% n=9	Relapse 47.06% n=8	Stability 83.33% n=20	Relapse 16.67% n=4	0.035¥*

*Statistically significant at $P < 0.05$

¥chi-square

Table XIII. Subgroup 2 (RIF) to Group 2 comparability regarding age, treatment time, posttreatment time and cephalometric variables at T1 (t test).

Variables	Subgroup 2 (RIF) (1-Piece) (N=12)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Age (y)	24.25	7.78	26.30	9.92	0.534
Treatment time (y)	4.02	2.78	1.27	1.23	0.000*
Posttreatment time (y)	3.61	1.42	3.71	3.20	0.918
Maxillary component					
SNA (°)	82.37	4.43	78.17	5.63	0.030*
CoA (mm)	79.35	3.16	77.80	8.61	0.551
A-Nperp (mm)	1.05	4.28	-0.58	4.11	0.272
Mandibular component					
SNB (°)	80.65	5.19	76.52	7.95	0.112
IMPA (°)	87.78	9.66	84.09	7.54	0.216
Pog-NB (mm)	1.17	1.85	1.76	1.89	0.383
GoGn.OP(°)	24.40	6.03	25.70	6.73	0.575
Maxillomandibular relationship					
ANB (°)	1.70	5.03	1.70	5.33	0.998
Wits appraisal (mm)	-3.05	7.28	-2.36	6.87	0.784
Growth pattern					
FMA(°)	30.77	5.41	32.90	10.07	0.501
SN.GoGn(°)	39.60	6.45	44.22	11.48	0.206
SN.PP(°)	-1.35	3.72	0.29	4.36	0.269
SN.OP(°)	15.19	3.08	18.52	7.67	0.159
Maxillary dentoalveolar component					
Mx1.SN (°)	111.53	8.36	106.66	9.21	0.133
Mx1-NA (mm)	6.32	3.62	6.65	3.16	0.778
Mx1Tip-VRP (mm)	70.80	4.78	65.67	10.78	0.126
Mx6-PTV (mm)	22.27	6.18	21.14	5.82	0.593
Mandibular dentoalveolar component					
Md1-MP (mm)	40.31	3.88	40.35	4.64	0.980
Md6-MP (mm)	31.21	2.54	31.57	4.03	0.783
Md1-Apo (mm)	4.64	3.14	4.81	2.41	0.854
Dental relationships					
Overbite (mm)	-3.26	1.18	-3.68	2.39	0.575
Overjet (mm)	1.36	4.75	2.23	4.66	0.604
Interincisal angle (°)	121.09	12.35	125.01	10.12	0.315

*Statistically significant at $P<0.05$

Table XIV. Treatment changes comparison between Subgroup 2 (RIF) to Group 2 (4-piece) from T2 to T1 (t test).

Variables	Subgroup 2 (RIF) (1-Piece) (N=12)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	2.68	5.78	4.75	3.64	0.060
CoA (mm)	4.26	5.82	3.85	8.62	0.883
A-Nperp (mm)	1.95	4.51	3.83	2.96	0.143
Mandibular component					
SNB (°)	1.40	4.24	4.29	4.10	0.057
IMPA (°)	0.73	6.59	-0.05	5.77	0.716
Pog-NB (mm)	1.58	2.19	2.52	3.02	0.343
GoGn.OP(°)	-3.64	4.75	-4.18	4.86	0.751
Maxillomandibular relationship					
ANB (°)	1.25	3.56	0.41	4.72	0.588
Wits appraisal (mm)	-0.67	5.28	-0.08	5.23	0.751
Growth pattern					
FMA(°)	-1.99	3.94	-6.81	5.59	0.011*
SN.GoGn(°)	-2.51	4.77	-7.42	5.38	0.011*
SN.PP(°)	2.20	4.15	-2.49	5.21	0.010*
SN.OP(°)	1.12	4.42	-3.25	5.72	0.026*
Maxillary dentoalveolar component					
Mx1.SN (°)	-3.13	6.84	-2.23	5.87	0.684
Mx1-NA (mm)	-2.22	4.01	-1.68	3.42	0.677
Mx1Tip-VRP (mm)	2.85	4.16	3.99	8.26	0.656
Mx6-PTV (mm)	2.77	4.34	3.86	4.19	0.471
Mandibular dentoalveolar component					
Md1-MP (mm)	2.83	4.44	-1.04	3.01	0.003*
Md6-MP (mm)	2.01	4.06	-1.62	3.29	0.006*
Md1-Apo (mm)	-0.51	3.02	-2.50	2.51	0.043*
Dental relationships					
Overbite (mm)	4.29	2.22	4.84	2.21	0.487
Overjet (mm)	-0.77	4.61	0.62	4.71	0.403
Interincisal angle (°)	4.87	10.64	9.73	7.04	0.110

*Statistically significant at $P<0.05$

Table XV. Subgroup 2 (RIF) to Group 2 (4-piece) comparison regarding cephalometric variables at T2 (t test).

Variables	Subgroup 2 (RIF) (1-Piece) (N=12)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	85.20	4.17	83.13	6.22	0.305
CoA (mm)	83.06	5.18	81.64	10.81	0.670
A-Nperp (mm)	3.90	3.68	3.30	4.01	0.669
Mandibular component					
SNB (°)	82.01	4.36	80.92	5.52	0.553
IMPA (°)	89.01	9.50	83.65	6.55	0.055
Pog-NB (mm)	4.21	1.51	4.27	2.33	0.933
GoGn.OP(°)	20.19	5.86	21.80	5.88	0.443
Maxillomandibular relationship					
ANB (°)	3.19	3.10	2.21	2.53	0.319
Wits appraisal (mm)	-2.70	2.85	-2.88	3.95	0.889
Growth pattern					
FMA(°)	26.48	4.66	27.05	6.71	0.795
SN.GoGn(°)	35.59	4.99	37.61	8.71	0.462
SN.PP(°)	-0.16	3.90	-1,94	5.19	0.304
SN.OP(°)	15.40	6.06	15.80	6.20	0.853
Maxillary dentoalveolar component					
Mx1.SN (°)	107.43	9.02	104.10	7.53	0.250
Mx1-NA (mm)	4.48	4.12	5.02	2.39	0.620
Mx1Tip-VRP (mm)	73.71	4.83	70.15	11.64	0.319
Mx6-PTV (mm)	28.40	3.79	24.72	5.38	0.041*
Mandibular dentoalveolar component					
Md1-MP (mm)	41.82	4.48	39.65	5.45	0.242
Md6-MP (mm)	32.84	4.89	30.07	5.32	0.140
Md1-Apo (mm)	3.35	2.68	2.51	1.96	0.290
Dental relationships					
Overbite (mm)	0.80	0.44	1.08	0.72	0.233
Overjet (mm)	2.24	0.67	2.82	1.04	0.091
Interincisal angle (°)	127.96	8.44	134.63	7.62	0.022*

*Statistically significant at $P<0.05$

Table XVI. Posttreatment changes comparison between Subgroup 2 (RIF) and Group 2 (4-piece) from T3 to T2 (t test).

Variables	Subgroup 2 (RIF) (1-Piece) (N=12)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	0.29	2.88	-0.19	3.33	0.668
CoA (mm)	1.30	2.77	0.41	8.25	0.722
A-Nperp (mm)	-1.08	2.82	-0.09	2.55	0.298
Mandibular component					
SNB (°)	-0.06	2.38	-0.22	2.79	0.871
IMPA (°)	0.70	2.83	0.42	3.62	0.814
Pog-NB (mm)	0.21	0.41	-0.07	1.10	0.386
GoGn.OP(°)	-0.20	2.25	0.06	2.91	0.780
Maxillomandibular relationship					
ANB (°)	0.35	1.82	0.02	1.76	0.609
Wits appraisal (mm)	0.30	2.57	-0.45	2.95	0.458
Growth pattern					
FMA(°)	1.05	3.34	0.64	2.27	0.645
SN.GoGn(°)	1.45	3.60	0.59	3.14	0.418
SN.PP(°)	-0.12	2.09	0.55	3.72	0.505
SN.OP(°)	-0.04	2.26	0.54	4.08	0.595
Maxillary dentoalveolar component					
Mx1.SN (°)	1.03	4.69	-0.65	5.00	0.338
Mx1-NA (mm)	-0.05	2.39	-0.32	2.35	0.755
Mx1Tip-VRP (mm)	1.35	2.55	0.63	8.25	0.769
Mx6-PTV (mm)	0.90	2.34	0.04	3.65	0.465
Mandibular dentoalveolar component					
Md1-MP (mm)	0.12	1.18	0.52	3.48	0.700
Md6-MP (mm)	0.86	1.10	0.66	3.41	0.845
Md1-Apo (mm)	-0.15	1.22	0.11	1.20	0.545
Dental relationships					
Overbite (mm)	-0.82	1.44	-0.09	1.25	0.127
Overjet (mm)	0.36	1.42	-0.43	1.30	0.102
Interincisal angle (°)	-1.20	3.50	-0.36	5.69	0.643

Table XVII. Subgroup 2 (RIF) to Group 2 (4-piece) comparison of cephalometric variables at T3 (t test) and percentages of patients presenting with clinically significant open bite relapse between groups (chi-square test).

Variables	Subgroup 2 (RIF) (1-Piece) (N=12)		Group 2 (4-Piece) (N=24)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	85.51	4.06	82.77	6.40	0.186
CoA (mm)	84.54	5.26	82.73	9.34	0.540
A-Nperp (mm)	3.46	3.35	3.09	4.80	0.810
Mandibular component					
SNB (°)	82.09	5.13	80.86	6.06	0.551
IMPA (°)	90.39	7.66	84.14	6.16	0.012*
Pog-NB (mm)	4.13	1.85	4.24	2.06	0.874
GoGn.OP(°)	19.95	5.99	21.84	5.12	0.330
Maxillomandibular relationship					
ANB (°)	3.42	3.54	1.90	2.51	0.147
Wits appraisal (mm)	-2.53	3.43	-3.09	3.53	0.650
Growth pattern					
FMA(°)	27.01	5.33	26.80	7.33	0.928
SN.GoGn(°)	35.32	6.43	37.32	8.16	0.464
SN.PP(°)	-0.51	3.52	-1.73	5.21	0.470
SN.OP(°)	15.38	6.48	15.48	6.24	0.963
Maxillary dentoalveolar component					
Mx1.SN (°)	108.10	9.25	104.40	9.55	0.275
Mx1-NA (mm)	4.62	2.46	4.87	2.15	0.756
Mx1Tip-VRP (mm)	74.68	5.43	71.02	11.69	0.312
Mx6-PTV (mm)	28.66	4.16	24.99	6.04	0.067
Mandibular dentoalveolar component					
Md1-MP (mm)	42.04	5.14	40.07	4.42	0.242
Md6-MP (mm)	33.27	5.28	30.64	4.50	0.128
Md1-Apo (mm)	3.45	1.98	2.54	1.83	0.177
Dental relationships					
Overbite (mm)	0.60	1.07	1.00	1.21	0.339
Overjet (mm)	2.54	1.09	2.35	1.11	0.635
Interincisal angle (°)	126.15	8.83	134.15	8.13	0.010*
Clinically significant relapse	Stability	Relapse	Stability	Relapse	0.999¥
Percentage of patients (%)	83.33%	16.67%	83.33%	16.67%	
Number of patients	n=10	n=2	n=20	n=4	

*Statistically significant at $P < 0.05$

¥chi-square

Table XVIII. Posttreatment time of clinically stable/relapsed subjects' comparison in Group 1 (1-piece) and in Group 2 (4-piece) (t-tests).

Overbite status at T3	Clinically stable		Clinically relapsed		P
	mean	s.d	mean	sd	
Group 1 (1-piece) Posttreatment time (y)	7.07	4.58	9.01	4.45	0.282
Group 2 (4-piece) Posttreatment time (y)	4.87	2.77	2.64	0.62	0.382

3.2 ARTICLE 2

LONG-TERM STABILITY OF SURGICAL-ORTHODONTIC OPEN BITE TREATMENT: CLASS II VERSUS CLASS III

ABSTRACT

Introduction: Few specific studies are comparing Class II to Class III malocclusions on the long-term stability of anterior open bite surgical-orthodontic treatment.

Materials and Methods: Lateral cephs obtained from 46 treated patients were divided into two groups: Class II Group (21 patients) and Class III Group (25 patients). Overbite changes were compared at 3-time points: T1 (pretreatment), T2 (posttreatment) and T3 (follow-up) by using t-test. **Results:** Follow up time mean was 5.75 years (2 to 18.83 ys). Both Groups presented a positive overbite mean at T3, however, Class II Group presented with a smaller statistically significant clinical stability (57.14%) than Class III Group (88%). **Conclusion:** The null hypothesis was rejected, because, the clinical stability of Class II open bite surgical-orthodontic treatment was smaller than in Class III malocclusions.

INTRODUCTION

Open bite treatment demands titanic efforts from the clinicians, firstly because treatment goals are both static and functional, and secondly because results should be maintained in the long-term. When treatment plan involves an surgical-orthodontic approach, patients' expectations usually increase as well as our responsibilities on delivering a stable result.

Long-term stability of skeletal open bites treated using surgical-orthodontic approach has been a controversial issue, for both orthodontists and oral surgeons. Challenges are even greater when anteroposterior discrepancies (Class II and Class III) are present on a vertical dysplasia such as skeletal open bites.

Class II malocclusion can, theoretically, be surgical-orthodontic ly corrected by maxillary and or maxillomandibular advancements, depending on its etiology, severity, and the impact it causes on patients' esthetics and functions¹. Conversely, Class III malocclusions can be corrected surgical-orthodontic ly by maxillary advancement and or mandible set-back. Correction of high mandibular plane angle malocclusions can be achieved by counter-clockwise or clockwise rotation of the maxillomandibular complex with similar stable results.²⁻⁴

Open bite stability of Class II malocclusions corrections is referred to be smaller than those of Class III. However just a few specific and, well-designed studies investigated this speculation.⁵⁻⁸ The major problems with the current studies are related to sample heterogeneity and short posttreatment follow-up. As a common finding, those studies used to consider 1 or 2-year post-surgery follow-up, which is not an adequate follow-up length.^{9,10} Overbite behavior, which can be influenced by skeletal and dentoalveolar components, should be evaluated at least 2 or 3 years (ideally five years at least) after fixed appliances have been removed. Proffit¹¹ established a hierarchy of surgical procedures considering a short-term stability period, based on postsurgical follow-up of 1 year, however, recently an adequation to this parameter was taken into account.¹²

This study aims to test the null hypothesis that there is no difference in the long-term clinical stability of open bite surgical-orthodontic treatment when Class II subjects are compared to Class III.

MATERIAL AND METHODS

This study is the second part of research submitted and approved by the institutional review board of Bauru Dental School, University of Sao Paulo, Brazil, under the protocol number: CAAE 71636716.5.0000.5417.

The sample size was calculated based on 80% test power with a significance level of 5%; a minimum mean difference of 1.43 mm and a mean standard deviation of 1.6 mm. Hence, 21 subjects in each group were necessary to generate reliable results. Overbite relapse was used according to a previous study.¹³

Inclusion criteria comprised: initial anterior open-bite malocclusion of at least 1mm, treated orthodontically and surgically, Class II and Class III malocclusions, no previous orthodontic treatment; positive overbite after treatment; comparable retention protocols; facial trauma absence; buccofacial pathology absence, genetic syndromes/ congenital deformities absence.

The sample was divided into two groups:

Group 1: Class II comprised 21 patients (8 male, 13 female) with a mean age of 25.42 years (ranging from 15.08 years to 41.50 years). In only three patients orthognathic surgery was restricted to the maxilla, while the remaining 18 patients were treated by combining 1-piece Le Fort I to BSSO (Bilateral Sagittal Split Osteotomy). Surgical fixation with intraosseous wires was performed in 8 patients (38.09%), and 13 (61.91%) received rigid internal fixation. Regarding the type of Le Fort I osteotomy, 12 (57.14%) patients were treated with 1-piece Le Fort I and 9 (42.86%) patients with 4-piece Le Fort I osteotomy. Patients in this group were treated by different professional teams, including 6 surgeons, as described: surgeon # 1 (12 patients), surgeon # 2 (1 patient), surgeon # 3 (2 patients), surgeon # 4 (2 patients), surgeon # 5 (3 patients) and surgeon # 6 (1 patient)). The posttreatment follow-up interval began after orthodontic treatment and extended to the last posttreatment patient recall, which had a mean time of 6.34 years (ranging from 2 years to 18.83 years).

Group 2: Class III group comprised 25 patients (15 male, 10 female) with a mean age of 23.08 years (ranging from 14.83 years to 45.25 years). In only five patients orthognathic surgery was restricted to the maxilla, while the remaining 20 patients were treated by combining 1-piece Le Fort I to BSSO (Bilateral Sagittal Split

Osteotomy). Surgical fixation with intraosseous wires was performed in 6 patients (24%), and 19 (76%) received rigid internal fixation. Regarding the type of Le Fort I osteotomy, 13 (52%) patients were treated with 1-piece Le Fort I and 12 (48%) patients with 4-piece Le Fort I osteotomy. Patients in this group were treated by different professional teams, including 6 surgeons, as described: surgeon # 1 (13 patients), surgeon # 2 (1 patient), surgeon # 3 (4 patients), surgeon # 4 (3 patients), surgeon # 5 (1 patient) and surgeon # 6 (3 patients)). The posttreatment follow-up interval began after orthodontic treatment and extended to the last posttreatment patient recall, which had a mean time of 5.26 years (ranging from 2 years to 13.91 years).

Methods

Lateral cephs were obtained at three time points (T1-pretreatment, T2-posttreatment, and T3-long-term follow-up). Several x-ray machines were used and so different magnification factors were present, varying from 7% to 12.6%. All cephalometric measurements are described in Table I. Cephalometric tracings and magnification corrections were performed with Dolphin® Imaging 11.0 (Dolphin Imaging and Management Solutions, Chatsworth, Calif., EUA).

Error study

Error study assessment comprised 32 of the 138 lateral cephs which were randomly selected, retraced, and redigitized by the same operator (VLBS) after a 30-day interval. Random errors were calculated according to Dahlberg's formula ($Se^2 = \sum d^2 / 2n$),¹⁴ where Se^2 is the error variance and d is the difference between two determinations of the same variable, and the systematic errors with dependent t tests, at $P < 0.05$.¹⁵⁻¹⁷

Statistical analyses

Normal distribution of data in the sample was assessed by applying Kolmogorov-Smirnov tests. All variables showed a normal distribution in the two groups.

T tests were used to evaluate groups' comparability regarding age and chi-square test was used to compare the groups regarding sex, and type of fixation distributions.

Intergroup comparison of all variables at T1, T2-T1, T2, T3-T2 and T3 was performed by using t tests.

The Probability of clinical open bite stability was calculated dividing the number of events by the total sample amount and within the subgroups. The percentages of patients with clinically significant relapses in each group were compared with the chi-square test. Results were considered significant at $P < 0.05$. All statistical analyses were performed with Statistica software (Statistica for Windows 10.0; StatSoft, Tulsa, Okla.).

RESULTS

Three variables presented with significant systematic error (Mx1.SN; Mx1-NA; Interincisal angle), requiring caution when taking these measurements into account. Random errors varied within acceptable limits from 0.20mm (overbite) to 3.28mm (CoA).¹⁶

Both groups were comparable regarding initial age, treatment time, posttreatment time and sex after t-test and chi-square assessments, respectively (Tables II and III). Groups were comparable regarding the type of fixation distribution (WF and RIF) (Table VIII).

Group 1 (Class II) patients presented with a more retruded mandible, greater mandibular incisors buccal inclination, greater mandibular plane inclination, positive ANB angle and greater overjet than those of Group 2 (Class III) at T1 (Table III).

Regarding treatment changes, both groups presented with SNA angle and A-Nperp measurement increases (Table IV), however, Group 1 (Class II) showed a smaller increase than Group II (Class III). Groups presented a reduction in the inclination of the mandibular plane and more palatally inclined maxillary incisors. Considering ANB angle, Wits, and overjet measurements, Group 1 (Class II) had a decrease, while Group II (Class III) presented with an increase. Regarding occlusal plane inclination, mandibular molars, and incisors height, Group 1 (Class II) had an

increase in those measurements, while Group II (Class III) presented with a decrease (Table IV).

At the end of treatment (T2), despite treatment changes, groups tended to maintain their initial cephalometric differences except for overjet measurement which presented very similar values (Table V).

Posttreatment phase changes (T3-T2) were comparable among groups (Table VI).

Groups tended to maintain their initial cephalometric characteristics at T3.

Overbite

Initial overbite severity was comparable (T1), proportionally corrected with treatment (T2-T1), comparable at the end of treatment (T2), proportionally reduced in the posttreatment phase (T3-T2), and the long-term control (T3) remained positive. However, Group 1 (Class II) presented with smaller clinical overbite stability (57.14%) than Class III group (88%) (Table VII).

DISCUSSION

The Long-term posttreatment time of 5.75 years after fixed appliance removal present in this sample is an important factor which differentiates, positively, the conclusions of our study, since most of the previous studies considered only 1 or 2 years of postsurgical follow-up time ^{4,8}. Initial open bite severity was similar among groups allowing a comparable scenario for the open bite stability assessment.

As already expected, groups presented initial cephalometric differences, mainly related to the mandibular component, exposing the antagonistic nature of this two malocclusions.¹⁸⁻²⁰ Skeletal Class II characteristics in Group 1 showed that the anteroposterior discrepancy was due to a mandibular retrusion, whereas Group 2 revealed a maxillary retrusion and well-positioned mandible, which, in fact, may be the consequence of the clock-wise mandible rotation direction in the high-angle patients. Because only non-growing patients were selected, the greater vertical growth pattern found in Group 1 than in Group 2 must not have influenced the results. The significant greater ANB angle severity and Wits appraisal means in Class II group than in Class III group, demonstrated the skeletal and dental discrepancy of the sample. Dental compensations, which must be eliminated by presurgical orthodontic preparation, where also demonstrated the greater buccal inclination of mandibular incisors in Class II group and the lingually tipped mandibular incisors in

Class III group. Moreover, interincisal angle presented with a smaller mean in Class II group than in Class III group (Table III).

Regarding treatment changes, SNA angle and A-Nperp measurements presented a smaller increase in Group 1 than in Group 2, reflecting a logical tendency of promoting a minor maxillary advancement in Class II patients, because the mandible must be advanced to improve the patient profile. And the contrary is, also, true because Class III often requires great maxillary advancements and or mandible set-back.²¹ Maxillary impaction which is usually necessary to correct the divergence between palatal and mandibular planes results in a counter-clockwise rotation of the mandible as our results demonstrate with negative GoGn.OP values for both groups.³ The magnitude of overbite correction was almost the same in both groups

At the end of surgical-orthodontic treatment, initial cephalometric characteristics tended to remain among groups. The results of anteroposterior correction in both groups can also be explained by the interaction between ANB, overjet, and maxillary/mandibular incisor inclination at T2. In Class II group, the final ANB angle mean of 5.45° and the overjet mean of 2.5mm, by itself, cannot explain sagittal correction. However, the mandibular incisor buccal inclination and the maxillary incisor lingual inclination have compensated for the skeletal discrepancy (Table IV). Conversely, in Class III group, the final ANB mean of 1.63° with an overjet mean of 2.48mm is compensated by mandibular incisor lingual inclination and maxillary incisor buccal inclination. Comparable final overbite means were found between groups, allowing an equal comparison, since initial severity was also comparable. One factor that is, commonly, associated to relapse in surgical-orthodontic treatment of Class II and III open bite patients is the mandibular plane correction.^{3,4} Skeletal changes tend to be counteracted by dentoalveolar alterations, which is known as the compensatory mechanism.²² In other words, despite the relapse occurred in the counterclockwise correction of mandibular plane in Class II group, mandibular molars and incisors had an increase in the vertical plane, compensating for the tendency of opening the bite.

Posttreatment changes were not statistically significant among groups but demonstrated that the general relapse tendency follows to the reversion of the

treatment changes. Interestingly is that, although not statistically significant, Class II overbite mean (-0.75mm) decreased three-times more than Class III (-0.20mm).

After follow-up period, final overbite means were not statistically significant different among groups, however, Class II group mean (0.17mm) was much closer to an open bite (overbite<0mm) than Class III mean (0.87mm).

The evaluation of clinically significant stability, which is the main objective of this study, showed that overall sample presented with a clinically stability rate of 73.91%, corroborating other studies.^{23,24} It is hard to weight if patients went for speech therapist evaluation after treatment since it was not considered for this study.

At the end of posttreatment phase, Class II group (57.14%) presented with smaller clinically significant stability of overbite than Class III group (88%). Nine out of 21 patients in Class II group presented a clinical relapse and in Class III group, only 3 out of 25 ended up follow-up period with an overbite smaller than 0mm. These results are in agreement of several other studies,^{13,25-27} however most of them considered a short-term follow-up period and small sample size, hence our results tends to confirm that Class II surgical-orthodontic treatment is less stable than Class III in open bite patients with stronger evidence.

CONCLUSIONS

The null hypothesis was rejected because:

- Clinical stability of Class II malocclusion open bite surgical-orthodontic treatment was significantly smaller than in Class III malocclusions.

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Table I. Cephalometric variables description.

Maxillary component
1. SNA angle (°) SN to NA.
2. Co-A (mm) Condylion to A-point.
3. A-Nperp (mm) A-point to nasion-perpendicular.
Mandibular component
4. SNB angle (°) SN to NB.
5. IMPA (°) Incisor mandibular plane angle
6. Pog-NB (mm) Pogonion to NB
7. GoGn.OP(°) Mandibular plane to occlusal plane
Maxillomandibular relationship
8. ANB angle (°) NA to NB.
9. Wits appraisal (mm) Distance between perpendicular projections of Points A and B on the functional occlusal plane (plane drawn through points of occlusal contact between the first permanent molars and the first and second premolars).
Growth pattern
10. FMA (°) Frankfort mandibular plane angle.
11. SN.GoGn (°) SN to GoGn angle.
12. SN.PP (°) SN to palatal plane angle.
13. SN.OP (°) SN to functional occlusal plane angle.
Maxillary dentoalveolar component
14. Mx1.SN (°) Angle between maxillary incisor long axis and SN
15. Mx1-NA (mm) Distance from incisal edge of maxillary incisor to NA
16. Mx1Tip-VRP (mm) Distance from incisal edge of maxillary incisor to SN
17. Mx6-PTV (mm) Distance from mesial cusp of maxillary first molar to PTV
Mandibular dentoalveolar component
18. Md1-MP (mm) Perpendicular distance between incisal edge of mandibular incisor and mandibular plane.
19. Md6-MP (mm) Perpendicular distance between mesial cusp of mandibular first molar and mandibular plane.
20. Md1-Pogperp (mm) Perpendicular distance between incisal edge of mandibular central incisor and Pogperp (line perpendicular to mandibular plane, passing through pogonion).
Dental relationships
21. Overbite (mm) Distance between incisal edges of maxillary and mandibular central incisors, perpendicular to functional occlusal plane.
22. Overjet (mm) Distance between incisal edges of maxillary and mandibular central incisors, parallel to functional occlusal plane.
23. Interincisal angle (°) Angle between the intersection of maxillary and mandibular incisors long axis

Table II. Intergroup comparability regarding sex (chi-square).

Sex Group	Male	Female	Total
G1(Class II)	8	13	21
G2(Class III)	15	10	25
Total	23	23	46
P= 0.138			

Table III. Group 1 (Class II) to Group 2 (Class III) comparability regarding age, treatment time, posttreatment time and cephalometric variables at T1 (t test).

Variables	Group 1 (Class II) (N=21)		Group 2 (Class III) (N=25)		P
	Mean	s.d	Mean	s.d	
Age (y)	25.42	8.31	23.12	6.79	0.306
Treatment time (y)	2.74	2.79	2.19	1.86	0.424
Posttreatment time (y)	6.34	5.07	5.25	3.76	0.409
Maxillary component					
SNA (°)	80.50	4.96	79.95	5.24	0.721
CoA (mm)	78.09	6.71	79.07	5.93	0.600
A-Nperp (mm)	1.79	3.12	-0.03	4.61	0.130
Mandibular component					
SNB (°)	73.78	5.74	81.05	5.89	0.000*
IMPA(°)	89.84	7.47	82.15	8.88	0.002*
Pog-NB (mm)	1.06	1.49	2.14	2.08	0.053
GoGn.OP(°)	26.27	6.02	22.71	5.53	0.042*
Maxillomandibular relationship					
ANB (°)	6.72	4.65	-1.05	4.45	0.000*
Wits appraisal (mm)	3.74	5.72	-7.64	5.14	0.000*
Growth pattern					
FMA(°)	34.11	6.18	30.02	8.70	0.078
SN.GoGn(°)	45.58	8.09	40.10	9.65	0.045*
SN.PP(°)	0.76	3.05	0.15	4.05	0.573
SN.OP(°)	19.33	5.33	17.38	6.59	0.281
Maxillary dentoalveolar component					
Mx1.SN (°)	105.54	6.29	108.67	9.36	0.198
Mx1-NA (mm)	5.15	3.89	6.15	3.20	0.344
Mx1Tip-VRP (mm)	66.43	7.72	67.20	8.75	0.756
Mx6-PTV (mm)	19.89	3.95	22.16	5.30	0.112
Mandibular dentoalveolar component					
Md1-MP (mm)	40.66	4.07	38.95	4.03	0.161
Md6-MP (mm)	31.54	3.21	30.45	3.75	0.298
Md1-Apo (mm)	4.06	2.06	4.89	3.06	0.297
Dental relationships					
Overbite (mm)	-3.28	1.85	-3.15	1.82	0.812
Overjet (mm)	6.48	4.40	-1.17	2.04	0.000*
Interincisal angle (°)	119.01	9.58	129.08	12.11	0.003*

*Statistically significant at $P<0.05$

Table IV. Treatment changes comparison between Group 1 (Class II) and Group 2 (Class III) from T2 to T1 (t test).

Variables	Group 1 (Class II) (N=21)		Group 2 (Class III) (N=25)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	2.52	4.44	5.17	4.27	0.045*
CoA (mm)	3.70	5.06	1.70	7.42	0.300
A-Nperp (mm)	1.51	3.47	4.15	3.49	0.013*
Mandibular component					
SNB (°)	3.70	4.25	2.44	3.88	0.300
IMPA (°)	1.20	8.84	-0.14	6.27	0.550
Pog-NB (mm)	2.01	2.72	1.89	2.52	0.874
GoGn.OP(°)	-5.11	6.58	-1.58	3.98	0.030*
Maxillomandibular relationship					
ANB (°)	-1.17	4.12	2.69	3.36	0.001*
Wits appraisal (mm)	-5.17	5.34	3.65	4.72	0.000*
Growth pattern					
FMA(°)	-3.07	7.26	-4.22	5.40	0.541
SN.GoGn(°)	-3.82	7.67	-4.80	5.87	0.624
SN.PP(°)	-0.13	4.76	-2.14	4.22	0.136
SN.OP(°)	1.26	5.83	-3.21	6.01	0.014*
Maxillary dentoalveolar component					
Mx1.SN (°)	-4.98	6.14	-0.65	6.53	0.026*
Mx1-NA (mm)	-1.75	4.11	-1.50	2.78	0.809
Mx1Tip-VRP (mm)	2.92	4.99	3.68	6.63	0.667
Mx6-PTV (mm)	2.74	4.35	4.23	5.60	0.325
Mandibular dentoalveolar component					
Md1-MP (mm)	1.74	3.85	-0.31	3.24	0.054
Md6-MP (mm)	1.34	3.84	-1.04	3.43	0.031*
Md1-Apo (mm)	0.25	2.83	-2.80	3.06	0.001*
Dental relationships					
Overbite (mm)	4.20	1.86	4.23	1.92	0.968
Overjet (mm)	-3.94	4.73	3.66	2.22	0.000*
Interincisal angle (°)	7.61	8.31	5.59	10.25	0.471

*Statistically significant at $P<0.05$

Table V. Group 1 (Class II) to Group 2 (Class III) comparison regarding cephalometric variables at T2 (t test).

Variables	Group 1 (Class II) (N=21)		Group 2 (Class III) (N=25)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	83.03	5.27	85.13	4.22	0.141
CoA (mm)	81.74	6.12	80.78	7.17	0.630
A-Nperp (mm)	3.27	3.60	4.12	3.57	0.426
Mandibular component					
SNB (°)	77.59	4.68	83.49	4.57	0.000*
IMPA (°)	91.01	8.06	82.01	7.24	0.000*
Pog-NB (mm)	3.09	2.27	4.04	2.32	0.170
GoGn.OP(°)	20.96	5.87	21.12	4.97	0.917
Maxillomandibular relationship					
ANB (°)	5.45	3.69	1.63	2.39	0.000*
Wits appraisal (mm)	-1.64	4.07	-3.99	3.12	0.032*
Growth pattern					
FMA(°)	30.96	5.77	25.79	5.68	0.003*
SN.GoGn(°)	41.63	7.96	35.29	6.56	0.004*
SN.PP(°)	0.48	3.84	-1.99	5.02	0.071
SN.OP(°)	20.65	5.28	14.16	5.59	0.000*
Maxillary dentoalveolar component					
Mx1.SN (°)	100.70	7.14	108.02	8.05	0.002*
Mx1-NA (mm)	3.45	4.10	4.65	2.64	0.237
Mx1Tip-VRP (mm)	69.31	6.17	70.88	8.19	0.475
Mx6-PTV (mm)	22.68	4.25	26.40	4.64	0.007*
Mandibular dentoalveolar component					
Md1-MP (mm)	42.40	4.21	38.64	4.71	0.006*
Md6-MP (mm)	32.85	4.80	29.40	4.36	0.014*
Md1-Apo (mm)	4.32	2.20	2.08	2.01	0.000*
Dental relationships					
Overbite (mm)	0.84	0.56	1.07	0.66	0.212
Overjet (mm)	2.50	0.79	2.48	0.77	0.958
Interincisal angle (°)	126.65	9.29	134.67	7.27	0.002*

*Statistically significant at $P<0.05$

Table VI. Posttreatment changes comparison between Group 1 (Class II) to Group 2 (Class III) from T3 to T2 (t test).

Variables	Group 1 (Class II) (N=21)		Group 2 (Class III) (N=25)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	0.65	4.65	-0.68	3.45	0.270
CoA (mm)	1.74	5.58	2.83	7.78	0.595
A-Nperp (mm)	-0.11	4.84	-0.45	2.55	0.758
Mandibular component					
SNB (°)	0.46	4.64	-0.79	3.80	0.316
IMPA (°)	-0.48	5.96	1.13	6.69	0.396
Pog-NB (mm)	0.34	2.34	-0.25	1.84	0.337
GoGn.OP(°)	0.96	5.08	0.44	4.45	0.709
Maxillomandibular relationship					
ANB (°)	0.17	2.81	0.11	3.33	0.955
Wits appraisal (mm)	0.96	3.97	0.33	4.50	0.617
Growth pattern					
FMA(°)	0.30	5.28	0.73	6.05	0.802
SN.GoGn(°)	-0.68	5.83	0.85	6.35	0.401
SN.PP(°)	-1.45	4.28	0.67	3.37	0.065
SN.OP(°)	-1.63	4.61	0.41	3.03	0.076
Maxillary dentoalveolar component					
Mx1.SN (°)	1.66	7.67	-0.21	6.23	0.365
Mx1-NA (mm)	-0.42	2.85	-0.22	3.39	0.835
Mx1Tip-VRP (mm)	1.96	6.55	0.92	7.23	0.612
Mx6-PTV (mm)	0.87	4.42	0.52	4.44	0.789
Mandibular dentoalveolar component					
Md1-MP (mm)	0.49	3.62	0.77	3.89	0.802
Md6-MP (mm)	0.64	2.12	0.66	3.12	0.979
Md1-Apo (mm)	-0.35	2.13	0.15	1.75	0.383
Dental relationships					
Overbite (mm)	-0.75	1.28	-0.20	1.81	0.247
Overjet (mm)	0.01	2.04	-0.08	1.80	0.869
Interincisal angle (°)	-0.48	7.47	-1.77	7.65	0.569

Table VII. Group 1 (Class II) to Group 2 (Class III) comparison of cephalometric variables at T3 (t test) and percentages of patients presenting with clinically significant open bite relapse between groups (chi-square test).

Variables	Group 1 (Class II) (N=21)		Group 2 (Class III) (N=25)		P
	Mean	s.d	Mean	s.d	
Maxillary component					
SNA (°)	83.68	5.13	84.45	4.92	0.606
CoA (mm)	83.54	7.22	83.61	6.69	0.971
A-Nperp (mm)	3.19	3.40	3.66	3.78	0.660
Mandibular component					
SNB (°)	77.94	6.43	82.70	4.71	0.006*
IMPA (°)	90.57	5.68	83.14	8.61	0.001*
Pog-NB (mm)	3.42	2.25	3.78	2.42	0.607
GoGn.OP(°)	22.11	5.15	21.56	5.54	0.730
Maxillomandibular relationship					
ANB (°)	5.71	3.63	1.75	3.51	0.000*
Wits appraisal (mm)	-0.46	4.61	-3.66	3.62	0.011*
Growth pattern					
FMA(°)	31.34	7.66	26.53	5.78	0.019*
SN.GoGn(°)	41.08	9.91	36.15	5.50	0.038*
SN.PP(°)	-0.82	5.01	-1.31	3.60	0.703
SN.OP(°)	18.96	7.04	14.58	4.87	0.016*
Maxillary dentoalveolar component					
Mx1.SN (°)	102.21	10.14	107.81	8.26	0.045*
Mx1-NA (mm)	2.98	2.60	4.42	2.95	0.088
Mx1Tip-VRP (mm)	71.32	9.82	71.80	7.53	0.852
Mx6-PTV (mm)	23.51	4.14	26.92	5.40	0.022*
Mandibular dentoalveolar component					
Md1-MP (mm)	42.90	4.18	39.41	4.75	0.012*
Md6-MP (mm)	33.53	4.84	30.07	4.12	0.011*
Md1-Apo (mm)	3.96	2.04	2.24	2.32	0.011*
Dental relationships					
Overbite (mm)	0.17	1.06	0.87	1.77	0.118
Overjet (mm)	2.54	1.74	2.40	1.49	0.765
Interincisal angle (°)	126.15	8.02	132.90	12.93	0.043*
Clinically significant stability/relapse Percentage of patients (%) Number of patients	Stability	Relapse	Stability	Relapse	0.017¥
	57.14%	42.86%	88.00%	12%	
	n=12	n=9	n=22	n=3	

*Statistically significant at $P < 0.05$

¥chi-square

Table VIII. Intergroup comparability regarding the type of fixation (chi-square).

Type of Fixation Group	Wire (WF)	Rigid (RIF)	Total
G1(Class II)	8	13	21
G2(Class III)	6	19	25
Total	14	32	46
P= 0.300			

4 DISCUSSION

4 DISCUSSION

Long-term stability of surgical-orthodontic open bite treatment is a controversial issue which has brought interest not only to orthodontists but also to oral surgeons over the last decades. However, the inner difficulties in obtaining a proper prospective study design, such as randomized clinical trials with standardized orthodontic and surgical treatment, adequate sample size, isolating the possible influencing factors, with reliable posttreatment follow-up (at least 5 years), ended up limiting the available evidence.(HUANG, 2002; GREENLEE et al., 2011; FONTES et al., 2012) Retrospective studies, despite its limitations, can also bring important information to clinicians in order to answer clinical focal questions.

Firstly, is important to differentiate the results considering 4 correlated situations one can find: 1- Influence of orthodontic pretreatment (dentoalveolar) on the final overbite; 2- Skeletal stability/instability of the surgical procedure on the vertical plane; 3- Overbite dentoalveolar compensation maintaining the overbite; 4- Posttreatment factors (tongue thrust, condiles resorption). The interaction between these 4 processes lead to the long-term stability/relapse of open bite and in our study, the main objective is to assess the final result of overbite measurement. Some authors concluded that no difference was found on the vertical plane between 1-piece Le Fort I and 3-piece Le Fort I osteotomies (BAILEY et al., 1994a; HOPPENREIJS et al., 1997; PEREZ; SAMESHIMA; SINCLAIR, 1997). While others, considering the final overbite result regardless of what led to the overbite stability/instability, found that 1-piece was more stable(FISCHER; VON KONOW; BRATTSTROM, 2000; KRETSCHMER et al., 2010; ISMAIL; LEUNG, 2017) and some others considered 1-piece less stable than segmental ones such as 3-piece(TURVEY et al., 1988; ARPORNMAEKLONG; HEGGIE; SHAND, 2003). In this study, the percentages of stable subjects showed that, despite the higher stability percentage in Group 2 (83.33%) than in Group 1(65.52%), results were not statistically significant (Table VII). In Group 1 (1-piece), majority of subjects (19 out of 29 patients) remained with an overbite greater than 0mm. in Group 2 (4-piece) 20 out of 24 patients remained with a positive overbite after the long-term observation

period. Subgroup 1 (WF) contributed with 8 subjects presenting with clinical overbite relapses and a statistically significant negative overbite mean of -0.18mm. In Subgroup 2 (RIF), only 2, out of 10 subjects, presented a negative overbite at T3 (follow-up). In other words, fixation type seemed to influence overbite stability in the long-term more than surgery type.

Regarding the anteroposterior comparison on the long-term stability between Class II and Class III open bite subjects, the mandibular retrusion in Class II group and the maxillary retrusion with well positioned mandible in Class III group showed that anteroposterior discrepancy, in fact, the clock-wise mandible rotation direction is one of the in the high-angle patients (JANSON et al., 2016). However, Class II group presented with a stronger vertical growth tendency, but due to the fact that patients were not in active growing, this difference must have not influenced the results. The relapse of mandibular plane correction is, usually, associated to overbite relapse in surgical-orthodontic treatment of Class II and III open bite patients (REYNEKE et al., 2007; KOR; YANG; HWANG, 2014), and skeletal changes tends to be counteracted by dentoalveolar alterations (SOLOW, 1980). In the end of the posttreatment phase, despite, the final overbite means has not showed difference among groups, Class II group tended to an open bite (overbite<0mm), whereas, Class III mean was 0.87mm. As the main objective of this study, overbite stability at the end of posttreatment phase showed that 9 out of 21 patients in Class II group presented a clinical relapse. Class III group presented only 3 out of 25 subjects with an overbite smaller than 0mm, corroborating several other studies,(FISCHER; VON KONOW; BRATTSTROM, 2000; SWINNEN et al., 2001; IANNETTI et al., 2007; ESPELAND et al., 2008; JAKOBSONE et al., 2011) . So, with stronger evidence, because most of those studies were based on short-term follow-up and small sample size, our results confirm that Class II surgical-orthodontic treatment of open bite patients is less stable than Class III treatment.

5 CONCLUSIONS

5 CONCLUSIONS

The first null hypothesis was accepted because:

- There was no significant intergroup difference regarding the percentage of clinically stable patients;
- The type of fixation seems to influence the long-term stability of open bite surgical-orthodontic correction more than maxillary segmentation.

The second null hypothesis was rejected because:

- Clinical stability of Class II malocclusion open bite surgical-orthodontic treatment was significantly smaller than in Class III malocclusions.

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APPENDIXES

APPENDIX A – Declaration of exclusive use of the article 1 in thesis

DECLARATION OF EXCLUSIVE USE OF ARTICLE IN THESIS

We hereby, declare we are aware that the article “Long-term stability of surgical-orthodontic open bite treatment: Le Fort I versus 4-piece segmental Le Fort I osteotomy” will be included in the thesis of the student Vinicius Laranjeira Barbosa da Silva and may not be used in any other scientific production of the Graduate Program at Bauru Dental School, University of São Paulo.

Bauru, January 18, 2018.

Vinicius Laranjeira Barbosa da Silva

Guilherme Janson

APPENDIX B – Declaration of exclusive use of the article 2 in thesis

DECLARATION OF EXCLUSIVE USE OF ARTICLE IN THESIS

We hereby, declare we are aware that the article “Long-term stability of surgical-orthodontic open bite treatment: Class II versus Class III” will be included in the thesis of the student Vinicius Laranjeira Barbosa da Silva and may not be used in any other scientific production of the Graduate Program at Bauru Dental School, University of São Paulo.

Bauru, January 18, 2018.

Vinicius Laranjeira Barbosa da Silva

Guilherme Janson

ANNEX

ANNEX A – Institutional Review Board approval, protocol number 71636716.5.0000.5417 (front page) **PARECER CONSUBSTANCIADO DO CEP****DADOS DO PROJETO DE PESQUISA**

Título da Pesquisa: Estabilidade em longo prazo do tratamento cirúrgico da mordida aberta anterior por osteotomia tipo Le Fort I com e sem segmentação maxilar

Pesquisador: Vinicius Laranjeira Barbosa da Silva

Área Temática:

Versão: 2

CAAE: 71636716.5.0000.5417

Instituição Proponente: Universidade de São Paulo

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 2.332.849

Apresentação do Projeto:

As dificuldades de tratamento e a baixa estabilidade nos casos de Mordida Aberta Anterior, mesmo em casos tratados cirurgicamente, são motivos de frustração para pacientes e profissionais. O avanço e surgimento de novas técnicas cirúrgicas podem, em teoria, trazer maior estabilidade em longo prazo no tratamento dessa desafiante má-oclusão. A técnica de osteotomia tipo Le Fort I segmentada da maxila é uma promissora abordagem que aponta para uma maior estabilidade, no entanto, existem poucos estudos consistentes e específicos que avaliaram seus resultados em longo prazo na correção da mordida aberta anterior. Portanto, o objetivo desse trabalho é testar a hipótese nula de que não há diferença quanto a estabilidade em longo prazo da correção cirúrgica da mordida aberta anterior entre a osteotomia Tipo Le Fort I com e sem segmentação maxilar. A amostra será composta por 162 Telerradiografias previamente obtidas de 54 pacientes tratados em consultórios privados de Bauru, Araraquara e São Paulo. Serão divididos em dois grupos: Grupo Sem Segmentação (29 pacientes) e Grupo Com Segmentação (25 pacientes). As alterações na sobremordida serão comparadas em 3 tempos: T1 (pré-tratamento ortodôntico), T2 (imediatamente após a remoção do aparelho) e T3 (no mínimo 2 anos após a remoção do aparelho).

Objetivo da Pesquisa:

Comparar a estabilidade em longo prazo da correção cirúrgica da mordida aberta anterior entre as

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ANNEX A – Institutional Review Board approval letter, protocol number 71636716.5.0000.5417 (back page)**USP - FACULDADE DE
ODONTOLOGIA DE BAURU DA
USP**

Continuação do Parecer E-332848

duas técnicas empregadas.

Avaliação dos Riscos e Benefícios:

Riscos: Não há riscos para os sujeitos da pesquisa, pois trata-se de um estudo retrospectivo no qual as radiografias utilizadas constam nos prontuários dos mesmos. Haverá atenção para manter sigilo dos nomes dos sujeitos.

Benefícios: Os benefícios impactam diretamente na forma de tratamento de uma complexa má oclusão, influenciando na decisão dos ortodontistas e cirurgiões quanto à elaboração do plano de tratamento de pacientes adultos com mordidas abertas severas.

Comentários e Considerações sobre a Pesquisa:

Todas as inconsistências metodológicas foram esclarecidas tanto no projeto como na PB, porém o cronograma está incorreto, pois as atividades se iniciaram antes da aprovação do CEP.

Em relação ao preenchimento da PB, algumas sugestões:

- 1) Desenho: substituir "54 documentações" por "54 sujeitos da pesquisa". Evitar o uso do termo "paciente".
- 2) Desfecho primário: Inserir os parâmetros utilizados para analisar estabilidade.
- 3) Corrigir cronograma.

Considerações sobre os Termos de apresentação obrigatória:

Os termos estão apropriados.

Recomendações:

Por favor, corrigir o cronograma.

Conclusões ou Pendências e Lista de Inadequações:

Nenhuma

Considerações Finais a critério do CEP:

Esse projeto foi considerado APROVADO na reunião ordinária do CEP de 11/10/2017, com base nas normas éticas da Resolução CNS 466/12, no entanto solicita-se a correção do cronograma. Ao término da pesquisa o CEP-FOB/USP exige a apresentação de relatório final. Os relatórios parciais deverão estar de acordo com o cronograma e/ou parecer emitido pelo CEP. Alterações na metodologia, título, inclusão ou exclusão de autores, cronograma e quaisquer outras mudanças que sejam significativas deverão ser previamente comunicadas a este CEP sob risco de não aprovação do relatório final. Quando da apresentação deste, deverão ser incluídos todos os TCLEs e/ou termos de doação assinados e rubricados, se pertinentes.

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ANNEX A – Institutional Review Board approval, protocol number 71636716.5.0000.5417 (front page)

USP - FACULDADE DE ODONTOLOGIA DE BAURU DA USP

Continuação do Parecer: 2.302.8-49

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_664401.pdf	14/09/2017 21:43:47		Aceito
Outros	QuestionarioTecnico_Revisado.pdf	14/09/2017 21:05:52	Vinicius Laranjeira Barbosa da Silva	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	JustificativadeDispensadoTCLE.pdf	14/09/2017 21:04:44	Vinicius Laranjeira Barbosa da Silva	Aceito
Declaração de Pesquisadores	OficioPesquisador.pdf	14/09/2017 21:04:01	Vinicius Laranjeira Barbosa da Silva	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_Revisado.docx	14/09/2017 21:03:21	Vinicius Laranjeira Barbosa da Silva	Aceito
Declaração de Pesquisadores	Termo_de_Compromisso.pdf	30/05/2017 11:07:04	Vinicius Laranjeira Barbosa da Silva	Aceito
Declaração de Pesquisadores	Termo_autoriza_Sao_Paulo.pdf	30/05/2017 11:04:06	Vinicius Laranjeira Barbosa da Silva	Aceito
Declaração de Pesquisadores	Termo_autoriza_Bauru.pdf	30/05/2017 11:02:50	Vinicius Laranjeira Barbosa da Silva	Aceito
Declaração de Pesquisadores	Termo_autoriza_Araraquara.pdf	30/05/2017 11:02:30	Vinicius Laranjeira Barbosa da Silva	Aceito
Declaração de Pesquisadores	DeclaracaodeConfidencialidade.pdf	30/05/2017 10:58:12	Vinicius Laranjeira Barbosa da Silva	Aceito
Declaração de Instituição e Infraestrutura	Termo_de_Aquiescencia.pdf	30/05/2017 10:57:03	Vinicius Laranjeira Barbosa da Silva	Aceito
Folha de Rosto	FolhadeRostoFinal.pdf	30/05/2017 10:55:43	Vinicius Laranjeira Barbosa da Silva	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

BAURU, 17 de Outubro de 2017

Assinado por:

Ana Lúcia Pompéia Fraga de Almeida
(Coordenador)

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ANNEX B – Letter justifying Informed consent dismissal **Universidade de São Paulo
Faculdade de Odontologia de Bauru**

Departamento de Odontopediatria,
Ortodontia e Saúde Coletiva

Justificativa de Dispensa ao TCLE

Este documento tem por finalidade a solicitação da dispensa do Termo de Consentimento Livre e Esclarecido junto aos pacientes da amostra da pesquisa de Doutorado intitulada "Estabilidade em longo prazo do tratamento cirúrgico da mordida aberta anterior por osteotomia tipo Le Fort I com e sem segmentação maxilar", sob responsabilidade do pesquisador e aluno do Programa de Ciências Odontológicas Aplicadas da Faculdade de Odontologia de Bauru, Vinicius Laranjeira Barbosa da Silva N/USP 4790135 e de seu orientador Prof. Dr. Guilherme Janson. Para tal, seguem as justificativas abaixo:

- Trata-se de um estudo retrospectivo, o qual se utilizará de telerradiografias previamente obtidas em consultórios privados de Bauru, Araraquara e São Paulo.
- Essas radiografias já fazem parte do protocolo de diagnóstico, tratamento e preservação dos profissionais envolvidos e portanto não foram obtidas especificamente para o estudo.
- A especificidade do assunto abordado, o que não diminui sua importância clínico/científica, pelo contrário, valoriza o esforço em busca da resposta à pergunta focal do estudo, corroborado à escassez de trabalhos na literatura, ratificam a grande dificuldade em coletar essa amostra.
- Muitos pacientes se mudaram, não temos contato ou até foram à óbito. As radiografias foram obtidas com uma variabilidade grande tempo, abrangendo o período de 1988 à 2010, tornando quase impossível a obtenção do TCLE dos participantes.
- Para assegurar o anonimato dos pacientes, os consultórios privados, na pessoa de seu respectivo responsável técnico, apresentam um termo de autorização assinado para análise dos prontuários (ANEXOS I, II e III).

Vinicius Laranjeira Barbosa da Silva
Pesquisador

Prof. Dr. Guilherme Janson
Orientador

Bauru, 05 de abril de 2017.

Al. Dr. Octávio Pinheiro Brisolla, 9-75 – Bauru-SP – CEP 17012-901 – C.P. 73

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ANNEX C – AJO-DO manuscript submission guidelines

22/01/2018

American Journal of Orthodontics and Dentofacial Orthopedics

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