

Universidade Federal do Rio de Janeiro – UFRJ

Centro de Ciências da Saúde

Faculdade de Odontologia

TRATAMENTO DA DEFICIÊNCIA TRANSVERSAL DA MAXILA.

ESTUDO LONGITUDINAL.

**Janáina Cristina Gomes
CD, MO**

Tese submetida ao corpo docente da Faculdade de Odontologia da Universidade Federal do Rio de Janeiro - UFRJ, como parte dos requisitos, para a obtenção do Título de Doutor em Odontologia (Ortodontia).

Rio de Janeiro

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**TRATAMENTO DA DEFICIÊNCIA TRANSVERSAL DA MAXILA.
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Janaína Cristina Gomes, CD, MO

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Prof. Dr. Roberto Mário A. Lima Filho, CD, MO, DO**

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2 Crescimento e Desenvolvimento

3 Expansão rápida da maxila

4 Teses

I Título.

II Tese (Doutorado – UFRJ/Faculdade de Odontologia).

DEDICO

Ao meu saudoso e querido pai,

Jairo Gomes.

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RESUMO

GOMES, Janaína Cristina. Tratamento da deficiência transversal da maxila. Estudo longitudinal. Orientadores: Dra. Ana Maria Bolognese e Dr. Roberto Mário Amaral Lima Filho. Rio de Janeiro: UFRJ/Faculdade de Odontologia, 2009. Tese (Doutorado em Odontologia – Ortodontia). 65p.

Foram verificados os efeitos esqueléticos do tratamento precoce da deficiência transversal da maxila, com expansão rápida (ERM) e sua influência no crescimento e desenvolvimento normal da maxila, mandíbula e largura nasal. Estudo longitudinal com 240 radiografias cefalométricas laterais e pósterio-anteriores, de 30 pacientes caucasianos, com maloclusão Classe I, tratados apenas com ERM e avaliados nos períodos T1, T2, T3 e T4, com médias de idade de 8a 2m, 9a 4m, 13a 2m e 20a 7m, respectivamente. O grupo controle foi representado pelos valores cefalométricos do “Bolton Standards of Dentofacial Developmental Growth”, nas idades de 8a, 9a, 13a e 18a. Ocorreu deslocamento da maxila e da mandíbula para frente, giro da maxila no sentido horário e da mandíbula no sentido anti-horário. Houve aumento real, em largura do osso basal, somente na maxila. A largura nasal apresentou aumento, estatisticamente significativo, após expansão maxilar e continuou aumentando, devido ao crescimento. Houve correlação positiva entre as modificações ocorridas com o tratamento e os valores cefalométricos

do “Bolton Standards of Dentofacial Developmental Growth”. Portanto, a expansão rápida da maxila trouxe resultados benéficos para os pacientes com deficiência transversal da maxila, favorecendo o crescimento normal.

SUMMARY

GOMES, Janaína Cristina. Tratamento da deficiência transversal da maxila. Estudo longitudinal. Orientadores: Dra. Ana Maria Bolognese e Dr. Roberto Mário Amaral Lima Filho. Rio de Janeiro: UFRJ/Faculdade de Odontologia, 2009. Tese (Doutorado em Odontologia – Ortodontia). 65p.

The skeletal effects of the precocious treatment of the transverse deficiency of the jawbone were verified, with rapid expansion (ERM) and your influence in the growth and normal development of the jawbone, jaw and nasal width. I study longitudinal with 240 cephalometric X-rays lateral and posteroanterior, of 30 patient Caucasian, with malocclusion Class I, just treated with ERM and appraised in the periods T1, T2, T3 and T4, with averages of age of 8a 2m, 9a 4m, 13a 2m and 20a 7m, respectively. The group control was represented by the values cefalométricos of "Bolton Standards of Dentofacial Developmental Growth ", in the ages of 8a, 9a, 13a and 18a. Happened displacement of the jawbone and of the jaw forward, I rotate of the jawbone in the hourly sense and of the jaw in the counterclockwise sense. There was real increase, in width of the basal bone, only in the jawbone. The nasal width presented increase, statisticantly significant, after maxillary expansion and it

continued increasing, due to the growth. There was positive correlation among the modifications happened with the treatment and the values cephalometric of "Bolton Standards of Dentofacial Developmental Growth". Therefore, the fast expansion of the jawbone brought beneficial results for the patients with transverse deficiency of the jawbone, favoring the normal growth.

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LISTA DE SIGLAS e DEFINIÇÕES

ERM / RME – expansão rápida da maxila

PA – pósterio-anterior

SNA – ângulo formado pela união das linhas SN e NA, que expressa o grau de protusão e retrusão da maxila em relação a base do crânio.

SNB - ângulo formado pela união das linhas SN e NB, que expressa o grau de protusão e retrusão da mandíbula em relação a base do crânio.

SNSn (Eixo maxilar) – medida angular entre a base anterior do crânio (SN) e o ponto Sn localizado no contorno anterior da maxila, 2mm abaixo do plano palatal. Representa a tendência de crescimento vertical da maxila

1SN – ângulo formado pela intersecção do longo eixo do incisivo central superior e a linha SN, expressa a inclinação deste dente em relação a base do crânio

1PP – ângulo formado pela intersecção do longo eixo do incisivo central superior e o plano palatal, revela a inclinação deste dente em relação à maxila.

GoGnSN - ângulo formado pela união das linhas SN e GoGn, que expressa o grau de abertura ou fechamento do plano mandibular e a direção de crescimento vertical da face.

ArGoGn - ângulo formado pela união das linhas ArGo e GoGn, que expressa o grau de abertura ou fechamento do plano mandibular e a direção de crescimento vertical da face.

GoGn1 - ângulo formado pela união das linhas GoGn e longo eixo do incisivo inferior, que expressa o grau de inclinação axial do referido dente.

SNPP – ângulo formado pela intersecção das linhas SN e plano palatal, revela o grau de inclinação da maxila em relação à base do crânio.

ENAENP – distância linear entre a espinha nasal anterior e a espinha nasal posterior, revelando o comprimento anteroposterior dos ossos maxilares.

AFAS / ASFH – distância linear entre o ponto Na e o plano palatal, representando a altura facial anterosuperior.

AFAI / LAFH – distância linear entre o plano palatal e o ponto mento, representando a altura facial anteroinferior

AFPS / PSFH – distância linear entre o ponto S e o plano palatal estendido posteriormente, representa a altura facial posterosuperior.

AFPI / LPFH – distância linear entre o plano palatal estendido posteriormente e o ponto gônio, representa a altura facial posteroinferior.

SGN – distância linear entre o ponto S e o Ponto Gn, expressa a direção de crescimento da face.

ArGo – distância entre os pontos Ar e Go, mostra o crescimento do ramo da mandíbula

GoPog - distância entre os pontos Go e Pog, mostra o crescimento do corpo da mandíbula

LN_s / NW (Largura nasal) – distância entre os pontos NC, expressa em milímetros a largura nasal.

LMxDi / RMxW (Largura maxilar Direita) – distância entre os pontos J e a linha facial frontal do lado direito e expressa em milímetros.

LMxEs / LMxW(Largura maxilar Esquerda) – distância entre os pontos J e a linha facial frontal do lado esquerdo e expressa em milímetros.

LMd / MdW (Largura Mandibular) - distância , em milímetros, entre os pontos Ag.

A6A6 (Relação intermolares superiores) – distância entre os pontos A6. Expressa em milímetro a distância entre a porção coronária da face vestibular dos molares superiores.

B6B6 (Relação intermolares inferiores) – distância entre os pontos B6. Expressa em milímetro a distância entre a porção coronária da face vestibular dos molares inferiores.

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1 INTRODUÇÃO

A deficiência maxilar transversa pode se manifestar pela mordida cruzada uni ou bilateral, parcial ou total. Existem casos, com esse tipo de deficiência, que não apresentam mordida cruzada, nos quais a oclusão é aparentemente normal, mas há compensação pela inclinação axial dos dentes e processos alveolares maxilares para palatino e dos mandibulares para vestibular.

Deficiências maxilares transversais conduzem a diferentes manifestações clínicas, como: hipoplasia maxilar, crescimento facial assimétrico, posicionamento e desvios funcionais da mandíbula, estética dentofacial alterada, condições periodontais adversas, inclinações dentárias instáveis e outros problemas funcionais decorrentes da constrição maxilar.

Se, por um lado, essa deformidade é considerada um dos problemas esqueléticos que mais sequelas podem causar na região maxilomandibular, por outro lado, é também, a que melhor responde às alterações ortopédicas dentre todas as outras regiões do complexo craniofacial.

A expansão rápida da maxila (ERM), terapia que emprega forças ortopédicas para abertura da sutura palatina, é a prática mais comumente utilizada no tratamento dessas deformidades. O objetivo principal desse procedimento é corrigir a discrepância em largura entre as bases apicais da

maxila e mandíbula, permitindo uma relação oclusal mais estável e normal, equilíbrio muscular fisiológico, com os dentes em relação transversa ideal e com inclinação vestibulolingual mais adequada.

Estudos clínicos sobre os efeitos a curto prazo da expansão rápida da maxila são unânimes em mostrar que, no sentido sagital e vertical, ocorre deslocamento da maxila para baixo e para frente e extrusão dos dentes posterosuperiores, o que induz à rotação da mandíbula no sentido horário, com conseqüente aumento na altura facial anteroinferior. (Haas 1965; Haas 1970; Wertz 1970; Wertz and Dreskin 1977; Chung and Font 2004). No sentido transverso, há aumento significativo na largura maxilar e nasal (Haas 1961; Wertz 1970; Wertz and Dreskin 1977; Baccetti, Franchi et al. 2001; Chung and Font 2004), sendo que essas mudanças repercutem no comprimento e na largura do arco maxilar (Haas 1961; Wertz 1970; Wertz and Dreskin 1977; Lima 2002; Lima, Lima et al. 2004; Lima, Lima Filho et al. 2005).

Nos estudos a longo prazo, os efeitos deste tratamento não apresentaram expressão significativa, no sentido sagital e vertical, mostrando que as alterações verificadas logo após expansão rápida da maxila tendem a retornar às posições iniciais, o que se mostra positivo, pois estende esta terapia aos pacientes com padrão de crescimento vertical (Haas 1980; Velazquez, Benito et al. 1996; Chang, McNamara et al. 1997; Garib, Henriques et al. 2001). No sentido transversal, o aumento em largura da base apical do osso maxilar mostrou-se estável, exibindo apenas alteração da inclinação vestibulo-lingual dos dentes posteriores, o que justifica a recomendação de sobrecorreção na terapia de expansão maxilar (Haas 1980; Baccetti, Franchi et

al. 2001; Lima Filho, Lima 2004; Lima, Lima Filho et al. 2005). Este aumento em largura do arco maxilar induz resposta espontânea do arco mandibular, que se reflete em mudanças positivas nas dimensões do mesmo (Lima, Lima et al. 2004).

Incontestáveis efeitos adversos ocorrem no crescimento e desenvolvimento da maxila quando do não tratamento de sua deficiência transversa. Relatos sobre o comportamento da maxila e mandíbula são escassos, no que diz respeito ao seu crescimento e desenvolvimento, em pacientes que foram tratados apenas com expansão palatina rápida.

O propósito dos autores foi verificar os efeitos esqueléticos tridimensionais da expansão palatina rápida e a influência no crescimento e desenvolvimento da maxila e mandíbula.

2 PROPOSIÇÃO

A proposta dos autores consistiu em:

- 2.1 avaliar os efeitos esqueléticos e dentários nas dimensões sagital, vertical e transversal;
- 2.2 correlacionar as modificações esqueléticas ocorridas com os parâmetros normais do “Bolton Standards of Dentofacial Developmental Growth”, e
- 2.3 avaliar as alterações ocorridas na largura nasal.

3 DELINEAMENTO DA PESQUISA

3.1 CARACTERIZAÇÃO DA AMOSTRA

A presente pesquisa clínica consistiu em estudo de coorte obtido de uma mesma população. Todos os indivíduos foram atendidos e tratados por único pesquisador, na Clínica Lima Ortodontia S/C Ltda., em São José do Rio Preto, SP, entre 1975 e 1991.

A amostra foi constituída de pacientes no início da dentição mista, apresentando Classe I de Angle com discrepância esquelética maxilomandibular transversal, deficiência maxilar real ou relativa e arco inferior com discrepância de modelo não excedendo 1,5mm negativo. Estes critérios de inclusão caracterizaram uma amostra de conveniência. Os pacientes foram submetidos, exclusivamente, à expansão rápida da maxila utilizando o expensor de apoio basal no osso maxilar e seguindo o protocolo de HAAS (1961), sem qualquer subsequente terapia ortodôntica.

Este estudo consistiu na observação longitudinal, de 240 radiografias cefalométricas em norma lateral e posteroanterior de 30 pacientes caucasianos, na fase de dentição mista, com maloclusão Classe I, sendo 12 do gênero masculino e 18 do feminino, que representaram o grupo tratado **(T)**.

Toda documentação do grupo T foi realizada na mesma clínica onde os pacientes foram tratados, sendo executadas antes do início do tratamento (**T₁**); acompanhamento a curto prazo, um ano após expansão (**T₂**); progresso, cinco anos após expansão (**T₃**) e a longo prazo, onze anos após expansão, tendo o completo estabelecimento da dentição permanente (**T₄**). Todos os procedimentos relativos à documentação ortodôntica seguiram critérios de padronização e controle de qualidade, preconizados pelo *American Board of Orthodontics Dental Cast Guide*.

O grupo controle (**C**) foi representado pelos valores cefalométricos médios do “Bolton Standards of Dentofacial Developmental Growth”, fornecendo dados de pacientes com oclusão excelente nas idades de 8, 9, 13 e 18 anos.

Como a população estudada (**T**) foi acompanhada durante um longo período algumas radiografias foram perdidas e seus dados não farão parte da análise estatística. As médias de idade e o número de pacientes avaliados em cada fase do tratamento estão expressas no Quadro 1.

Quadro 1 Idade para as fases de avaliação pré-tratamento (**T₁**), acompanhamento a curto prazo (**T₂**), progresso (**T₃**) e a longo prazo (**T₄**).

Grupos	T₁ n = 26	T₂ n = 27	T₃ n = 28	T₄ n = 29
Média de idade	8a 2m	9a 4m	13a 2m	20a 7m
Amplitude	7a - 9a 10m	7a 8m - 10a 10m	12a 8m - 14a 11m	18a – 23a 9m

3.2 CONFECÇÃO DO EXPANSOR

O expansor tipo Haas foi confeccionado pelo mesmo profissional para todos os pacientes do grupo T. Após separação adequada dos primeiros

molares permanentes, primeiros pré-molares ou primeiros molares decíduos, de acordo com a fase de desenvolvimento dental do paciente, foram adaptados anéis pré-fabricados (Unitek-3M), respectivamente.

Após a adaptação dos anéis (Figura 1A, página 9), fez-se à moldagem na arcada maxilar, para a transferência dos mesmos, com alginato *Jeltrate* (Dentsply-Caulk) em moldeiras TP (TP Orthodontics, Inc.), obtendo as impressões negativas. A remoção dos anéis se realizou com alicate ETM (ETM-347), sendo os dentes separados novamente. Em seguida, o molde foi lavado em água gessada para remoção do ácido algínico e muco, enxaguado em água corrente e, finalmente, os anéis foram transferidos para suas respectivas posições e fixados no molde (Figura 1B, página 9). O gesso pedra branco tipo IV Mossoró foi manipulado em espatulador à vácuo e vazado o molde com auxílio de vibrador, para obtenção do modelo de trabalho.

A estrutura metálica do aparelho foi confeccionada com duas barras de fio de aço inoxidável de 0.040 de polegada de diâmetro (Unitek-3M), contornando as superfícies vestibular e palatina dos anéis em ambos hemiarcos, com o máximo de contato possível, no terço cervical dos anéis e dos dentes não anelados. A extensão das extremidades palatinas em direção à rafe palatina mediana, levemente afastadas da mucosa, serviu de ligação para os anéis e a porção acrílica a ser incorporada para ancoragem.

As barras de aço foram unidas a cada par de anéis por brasagem, utilizando-se solda de prata *Summit* 0,031 de polegada de diâmetro (Summit Orthod. Co.) e maçarico (603-014) da Unitek-3M.

Empregou-se parafuso expansor da série Summit 110M (044-001) da Summit Orthod. Co., montado sobre uma lâmina de cera 7 rosa perpendicular ao longo eixo do parafuso. A base dessa lâmina foi recortada para se adaptar ao contorno do palato, de modo que o centro do parafuso ficasse posicionado diretamente sobre a linha mediana (Figura 1C, página 9) e as bordas laterais do mesmo estivessem, aproximadamente, de 1 a 2 mm afastado do palato. No sentido antero-posterior, o parafuso foi posicionado na região mais posterior do arco maxilar, estando o eixo central do mesmo na direção do ponto de contato entre os segundos molares decíduos e primeiros molares permanentes (Figura 1C, página 9). O modelo foi, então, preparado com pincel $\frac{3}{4}$ de polegada (075-007) e isolante líquido, ambos da Great Lakes (Great Lakes Orthod. Ltd.) e aplicou-se a resina acrílica autopolimerizável rosa *Biocryl* (Great Lakes Orthod. Ltd.), de modo a cobrir o parafuso e as barras palatinas, visando unir o parafuso à estrutura metálica, tornando-os uma peça única (Figura 1D,E,F, página 9).

Em seguida, o aparelho foi removido do modelo de trabalho e a cera eliminada, possibilitando a abertura do parafuso expansor, que foi acionado com segmento de fio de aço inoxidável 0,040 de polegada de diâmetro, para afastar as porções acrílicas até o final da extensão do parafuso e propiciar melhor acabamento.

O acrílico foi recortado com brocas 82T e 84T (Summit Orthod. Co.), de tal modo que todas as bordas em contato com a mucosa palatal ficassem bem arredondadas e a parte superior do palato aliviada. A porção metálica recebeu aplicação de pasta 710 (RMO[®]) e, em seguida polimento com

Fabulustre[®] (GFC), em rodas de pano e feltro *Dixon* 4 x 24 (Summit Orthod. Co.), acopladas ao motor de bancada SA (GE). Na porção acrílica, utilizou-se o creme abrasivo *Polish* GL0470 (Great Lakes Orthod. Ltd.) em rodas de pano e feltro, acoplado ao mesmo motor acima mencionado e, finalmente, recebeu laqueamento com *Acrypol* (Scheu-Dental) com pincel N^o 3 (075-004) da Great Lakes Orthod. Ltda.

A porção acrílica que esteve em contato com a mucosa do palato não foi desgastada nem polida, ficando restrita à região do palato menos vascularizada, estendendo-se dos primeiros molares decíduos aos primeiros molares permanentes e respeitando as rugosidades palatinas, margens gengivais livres e o tecido que recobre as foraminas alveolares posteriores.

Após a remoção dos separadores, efetuou-se a profilaxia dos dentes superiores, utilizando-se taça de borracha e pasta profilática. Depois do preparo do aparelho e assepsia, este foi fixado, com isolamento relativo, aos dentes-suporte utilizando cimento fosfato de zinco *Ames* (Teledyne Water

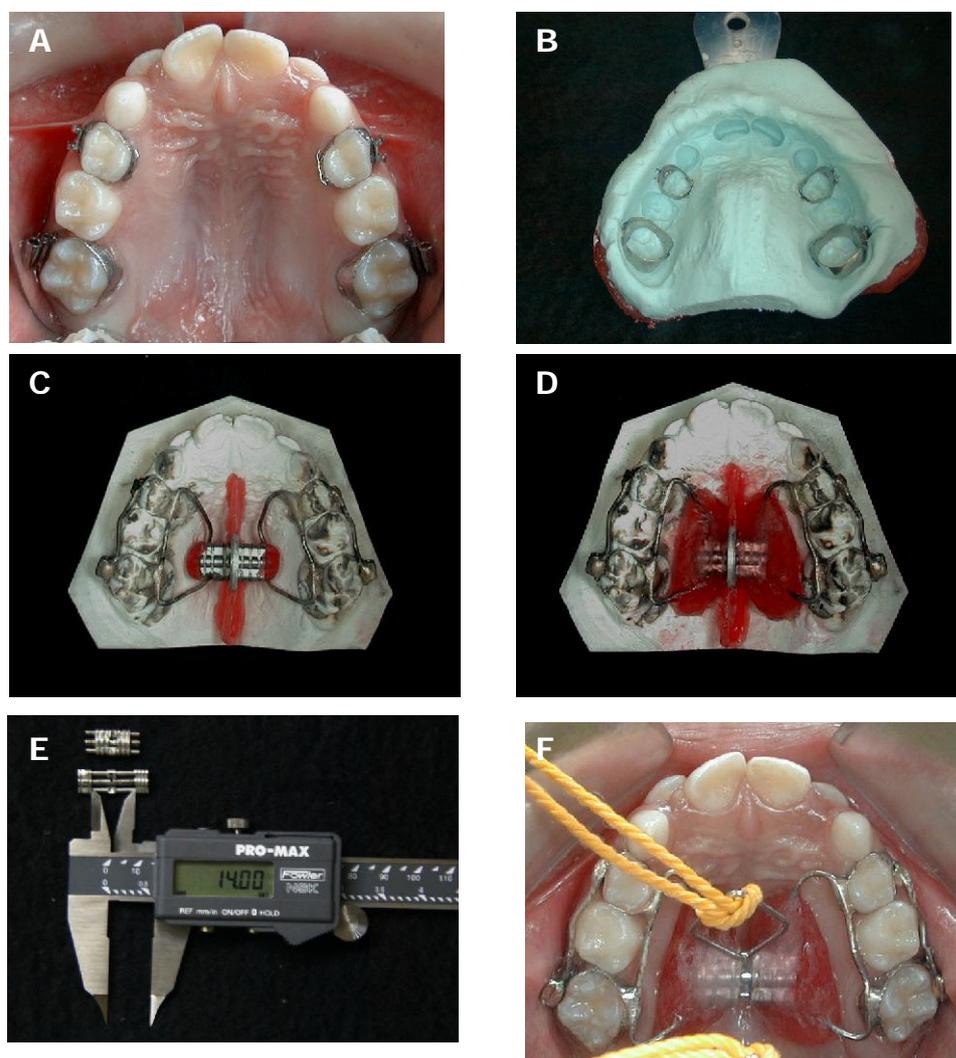


Figura 1 Fotografias ilustrando a sequência de confecção do aparelho expansor tipo Haas utilizado nos pacientes submetidos à expansão rápida da maxila: (A) adaptação dos anéis; (B) moldagem e transferência; (C) brasagem e colocação da cera; (D) aplicação da resina acrílica; (E) abertura do parafuso medida com paquímetro e (F) ativação do parafuso do expansor. **Fonte:** Lima, AL., 2002.

Pick).

3.3 PROTOCOLO DE ATIVAÇÃO

O parafuso expensor foi ativado duas vezes, equivalendo a $2/4$ de volta ou 0,5 mm, logo após a cimentação. Em seguida, os responsáveis pelo paciente receberam instruções sobre a ativação, profilaxia, possíveis ocorrências durante todo o período de abertura da sutura, e orientação para ativar o parafuso no sentido antero-posterior, $1/4$ de volta (0,25 mm) no período da manhã e $1/4$ à noite, sendo a chave amarrada a um cordão, como segurança, para evitar a deglutição ou aspiração da mesma. Os pacientes foram observados, semanalmente, durante 3 a 4 semanas.

Alcançada a expansão planejada para cada paciente, ou seja, a sobrecorreção ideal em todos os casos, com o parafuso aberto no mínimo 7 mm e no máximo 12 mm, o expensor foi estabilizado com acrílico, com o objetivo de evitar a movimentação do mesmo durante a função mastigatória e mantido em posição pelo período de 3 a 7 meses para contenção.

Cerca de 2 a 7 dias após a remoção do expensor, uma placa removível de acrílico, com ajuste seletivo no contorno palatino, foi colocada para contenção, permitindo o retorno dos dentes maxilares posteriores sobre-expandidos, conforme preconizado por HAAS (1970). O tempo de utilização dessa placa variou, permanecendo em alguns casos até a realização da documentação no acompanhamento a curto prazo (T2).

3.4 COLETA DE DADOS

3.4.1 Cefalogramas das radiografias cefalométricas laterais

Os cefalogramas foram realizados com as telerradiografias posicionadas sobre negatoscópio em sala escura, com folha de acetato de 0.03 polegadas de espessura e lápis HB, devidamente apontado.

Nos cefalogramas das radiografias cefalométricas laterais foram delineadas as estruturas ósseas da base anterior do crânio, o contorno anterior do osso frontal, os ossos nasais e a sutura frontonasal. A seguir delineou-se a espinha nasal posterior, palato duro e assoalho das fossas nasais até a espinha nasal anterior e o contorno anterior da maxila. A mandíbula foi reproduzida desde o ponto articular, passando por seu ramo e corpo, até os contornos internos e externos da sínfise. Os dentes desenhados foram os primeiros molares e os incisivos centrais permanentes, tanto superiores quanto inferiores, escolhendo sempre o incisivo central mais projetado. Nas estruturas bilaterais foi traçada a imagem do lado esquerdo, por ser a mais próxima aos posicionadores auriculares, por onde passa o raio central do feixe de raio X.

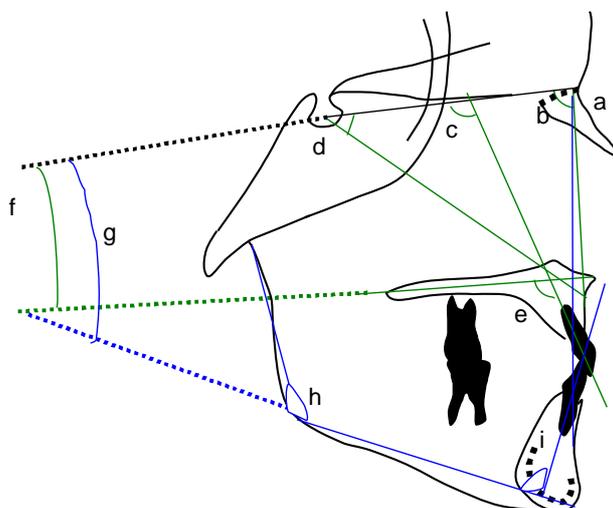


Figura 2 Representação das medidas angulares estudadas nos cefalogramas de perfil foram SNA (a), SNB (b), 1.SN (c), SNSn (d), 1.PP (e), SNPP (f), GoGnSN (g), ArGoGn (h), GoGn.1 (i).

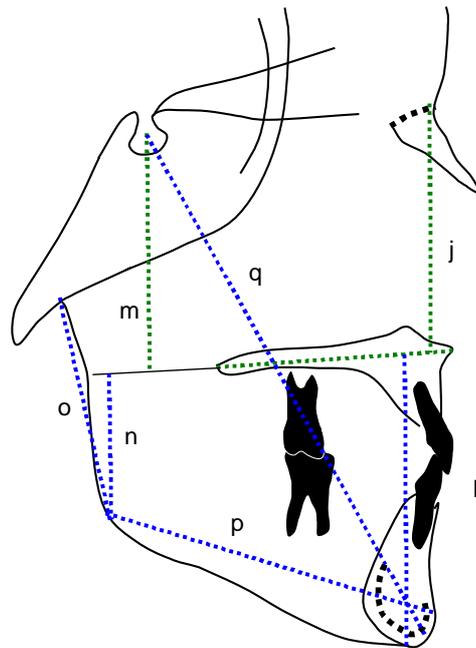


Figura 3 Representação das medidas lineares avaliadas nos cefalogramas de perfil foram AFAS (j), AFAI (l), AFPS (m), AFPI (n), ArGo (o), GoPog (p), SGn (q).

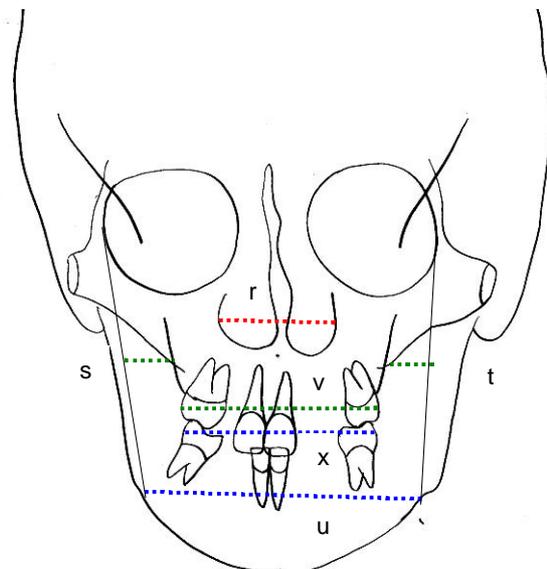


Figura 4 Representação das medidas lineares analisadas nos cefalogramas pósterio-antiores foram LNs (r), LMxDi (s), LMxEs (t), LMD (u), A6A6 (v), B6B6 (x).

3.5 ESTUDO DO ERRO

Para avaliar a reprodutibilidade das medidas, foram feitos testes preliminares para verificação do erro no método empregado.

Foram realizados, pelo mesmo examinador, os traçados cefalométricos laterais e pósterio-anteriores, a marcação dos pontos e as medidas propostas, de dois indivíduos que constituíam as amostras de cada grupo. Estas medidas foram efetuadas em dois intervalos de tempo, comparadas e quantificado o erro intra-investigador, que alcançou 0,20%.

3.6 ANÁLISE DOS DADOS

Utilizou-se de método comparativo, com avaliação longitudinal, entre os quatro grupos com tratamento, a fim de analisar as modificações ocorridas nos ossos da face. Foi empregado o teste “t” de Student pareado com nível de significância de $p < 0,05$.

Os valores médios do grupo controle foram comparados com os respectivos valores médios do grupo com tratamento, em cada momento, de acordo com as idades correspondentes, onde foi aplicado o teste “t” para uma amostra (one-sample t test) com significância de 5%, para identificar alterações esqueléticas na maxila e mandíbula após o tratamento e estudar o padrão de crescimento.

4 DESENVOLVIMENTO DA PESQUISA

4.1 ARTIGO 1

Longitudinal evaluation of the skeletal and dental effects of a transverse maxillary deficiency treatment. Janaína C. Gomes, Roberto M.A. Lima Filho, Ana Maria Bolognese. American Journal of Orthodontics and Dentofacial Orthopedics. Aguardando resposta

4.2 ARTIGO 2

Skeletal and dental analysis of the spontaneous response of the mandible to the rapid expansion of the maxilla: a longitudinal study. Janaína C. Gomes, Roberto M.A. Lima Filho, Ana Maria Bolognese. American Journal of Orthodontics and Dentofacial Orthopedics. Aguardando resposta

4.3 ARTIGO 3

Long-term effects of rapid maxillary expansion on nasal cavity width. Janaína C. Gomes, Roberto M.A. Lima Filho, Ana Maria Bolognese. Journal of Anatomy. Aguardando resposta

4.1 ARTIGO 1

Longitudinal evaluation of the skeletal and dental effects of a transverse maxillary deficiency treatment. Janaína C. Gomes, Roberto M.A. Lima Filho, Ana Maria Bolognese. American Journal of Orthodontics and Dentofacial Orthopedics.

ABSTRACT

Introduction: Skeletal alterations of major magnitude and stability can occur when the fast expansion of the maxilla occurs before the peak of puberal growth. The authors' objective was to verify the effects of early treatment of the transverse maxillary deficiency with rapid expansion of the maxilla and its influence on growth and development. **Methods:** A longitudinal study of 30 Caucasian patients (12 males and 18 females) in the mixed dentition phase, with Class I malocclusions treated with rapid maxillary expansion, was performed using 240 cephalometric radiographs in the lateral and posterior-anterior norm. The control group (C) was represented by the mean cephalometric values of the "Bolton Standards of Dentofacial Developmental Growth," which provided data for patients with excellent occlusion. **Results:** After the expansion, the observed vertical and sagittal skeletal alterations were smooth forward and downward maxilla movements. As for the transverse, there was an increase of the maxilla width. The turn, in the clockwise direction, of the palatal plane produced a vertical dimension increase in the maxilla height as a response to the treatment, and it continued to increase with growth, similar to that observed in the control group population. The dental response of the upper maxillary incisors was a vestibular inclination after the treatment. In relation to the upper inter-molar distance, the initial average values in group T were lower than those in group C, characterizing the posterior dental crossbite problem in the studied sample. With treatment, there was a significant increase of this distance at the T2 time point due to the dental expansion performed by the Haas maxillary disjunctor. **Conclusions:** It was concluded that the rapid maxillary expansion resulted in benefits for the patients presenting transverse maxillary deficiency, allowing them to return to the normal growth and development pattern.

INTRODUCTION

Several studies have confirmed the stability of rapid maxillary expansion (RME) based on the most complete database of diagnoses in the three dimensions. Hopefully, in the early years of the XXI century, the clinical

evidence and confirmed stability of long-term cases will stimulate interest and encourage doctors to incorporate the transverse skeletal evaluation in routine orthodontic diagnoses.¹

As part of the initial patient evaluation, the distance between the inner points of the upper first molars, or the transpalatal width, should be measured. Typically, a maxillary arch with a transpalatal width between 36 and 39 mm can accommodate permanent dentition, with normal dental size and without crowding or spacing. Maxillary arches smaller than 31 mm in width can present crowding and therefore require orthopedic expansion. Other factors, such as face type, soft tissue profile and muscle tonicity levels, should also be taken into consideration when deciding on the treatment.²

In clinical practice, the skeletal correction of the transverse discrepancy through the use of maxillary orthopedic expansion is successful until approximately the age of 14 to 15, depending on the patient's gender. The majority of investigators agree that RME with median palatine suture separation can be performed in young and adult individuals; however, with the advance of maturity, the skeletal rigidity limits the expansion and the stability of the extension.

Results for larger magnitude and skeletal stability can be obtained when the RME is performed before the pubertal growth peak, and, if performed after the pubertal growth peak, the transverse changes occur at the dentoalveolar level.^{3,4}

According to Melsen⁵, dental movement can occur with or through the alveolar bone. The second situation only happens with frontal or direct bone absorption. In such a case, absorption of the bone surface in the area of pressure of the periodontal ligament occurs, with compensatory positioning of the bone on the traction side. Nevertheless, when the magnitude of the force induces indirect bone absorption, the clasts absorb the outer bone in the direction of the periodontal ligament, restricting or delaying the dental movement. In the RME, the intense force used in the support teeth during the screw opening predisposes the hyalinization of the periodontal ligament on the pressure side.⁶ The movement-obstructed teeth become ideal supporting units

for the orthopedic maxillary movement. Thus, at the beginning of the expansion, the accumulated force is used to provide the median palatine suture separation in the maxilla. Afterwards, with the permanence of the residual forces, the orthodontic effect occurs.⁷

A functional posterior crossbite occurs in approximately 80% of the patients and results in the asymmetric positioning of the mandibular condyle when in maximum intercuspation. The early correction of this condition allows normal closing patterns, redirecting the developing occlusion and using the dynamic growth that is common in that period.⁸

The authors' objective was to verify the effects of the precocious transverse maxillary deficiency treatment with rapid maxilla expansion and its influence on maxillary growth and development. The long term effects in the sagittal, vertical and transverse dimensions of Class I patients were also evaluated, based on the skeletal and dental measures obtained in the lateral and posterior-anterior cephalometric radiographs.

SUBJECTS AND METHODS

The present clinical study consisted of a cohort study obtained from the same population. Every individual was served and treated by only one researcher at the Clínica Lima Ortodontia S/C Ltda., in São José do Rio Preto, SP, between 1975 and 1991.

The sample consisted of patients at the beginning of mixed dentition, presenting Class I with maxillomandibular transverse skeletal discrepancies, real or relative maxillary deficiencies, and normal lower arches or light crowding not exceeding 1.5 mm of the dentoalveolar discrepancy. Hence, the sample could be considered as the control as admission patterns were created. The patients were submitted exclusively to rapid maxillary expansion using the basal support expander in the maxillary bone and following the Haas⁹ protocol, without any subsequent orthodontic therapy.

This study consisted of the longitudinal observation of 240 cephalometric radiographs in the lateral and posterior-anterior norm of 30 Caucasian patients, including 12 males and 18 females, who were part of the treated group **(T)**.

All of the documentation was performed in the same clinic where the patients were treated, and it was completed at several time points, including before the treatment started (**T₁**), at the short-term follow-up taken one year after expansion (**T₂**), at the mid-term progress taken five years after expansion (**T₃**) and at the long-term follow-up taken eleven years after the expansion, with complete permanent dentition (**T₄**). All procedures related to the orthodontic documentation followed the standard criteria and quality controls, as recommended by the *American Board of Orthodontics Dental Cast Guide*.¹⁰

The control group (**C**) was represented by the mean cephalometric values of the “Bolton Standards of Dentofacial Developmental Growth,” providing data for patients with excellent occlusion at the ages of 8, 9, 13 and 18 years old.

As the studied population (**T**) was followed over a very long time, some radiographs were lost and thus will not be part of the statistical analysis. The average age and the number of patients evaluated in each treatment phase are presented in the table below.

Table 1 Age for the pre-treatment evaluation (**T₁**), short-term follow-up (**T₂**), progress (**T₃**) and long-term (**T₄**) phases.

Groups	T₁ n = 26	T₂ n = 27	T₃ n = 28	T₄ n = 29
Average Age	8y 2m	9y 4m	13y 2m	20y 7m
Amplitude	7y - 9y 10m	7y 8m - 10y 10m	12y 8m - 14y 11m	18y – 23y 9m

y=years; m=months

The screw expander was activated twice, at an equivalent of 2/4 back or 0.5 mm, just after cementation. The guardians of the patient were then instructed regarding the activation, prophylaxis and possible events that could occur during the period of suture opening, and they were instructed to turn the screw in the anterior-posterior direction, ¼ back (0.25 mm) in the morning and ¼ in the evening. The patients were observed on a weekly basis for 3 to 4 weeks.

For all the cases, once the planned expansion to the ideal correction was reached, with the screw expanded at a minimum of 7 mm and a maximum of 12 mm, the expander was stabilized with acrylics, with the objective of avoiding movement during the chewing function, and it was kept in that position for an average period of 6.4 months (3 – 7 months) for retention.

At around 2 to 7 days after the expander removal, an acrylic removable plate, with selective adjustment of the palatal contour, was used for contention, allowing the return of the over-expanded posterior maxillary teeth in accordance with the Haas¹¹ protocol. The time of plate use varied, and in some cases it lasted until the documentation at the short-term follow-up (T₂).

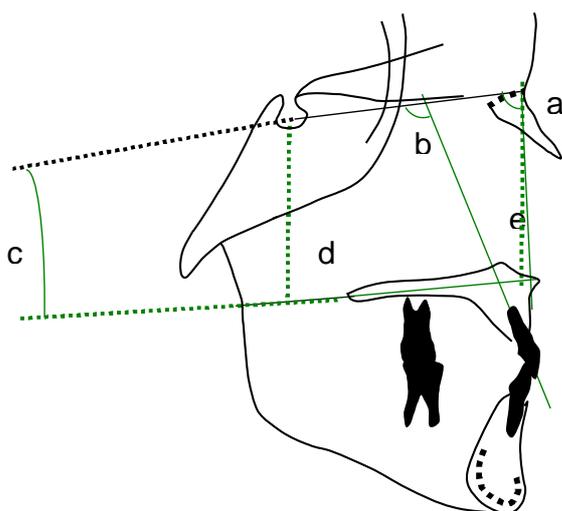


Figura 1 Representação de ângulo e medições lineares dos cefalogramas laterais foram SNA (a), 1.SN (b), SNPP (c), ASFH (d), e PSFH (e).

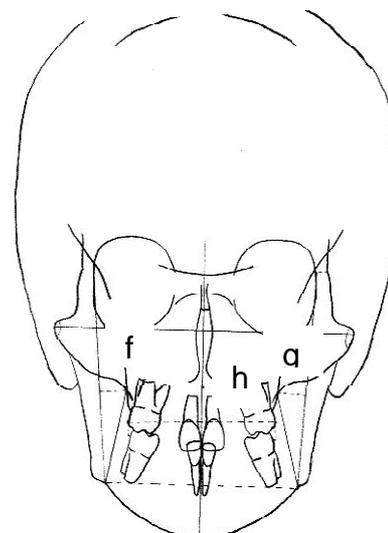


Figure 2 Representação das medições lineares avaliadas nos cefalogramas PA foram LMxDi (f), LMxEs (g) e A6A6 (h).

A comparative method was used with longitudinal evaluation among the groups at the T1-T2, T2-T3 and T3-T4 time points, according to the average age of the sample, with the aim of analyzing the maxilla behavior. The paired Student's t-test was used with a significance level of < 0.05.

The mean values of the control group were compared to the respective mean values of the treatment group at each time point, according to the corresponding ages, where the t-test was used for one sample (one-sample t test) with a significance of 5%.

RESULTS

The forward maxillary dislocation after the expansion was 0.04° , later reaching a T1 mean value of 80.88° and a T2 value of 81.44° . At T3, the SNA values continued to increase, but the increase was modest when compared to the behavior of Group C for the same period. At T4, there was a slight reduction from the SNA observed at the T3 time point in the treated group, while these values continued to increase in Group C.

The inclination of the upper incisors in relation to the cranial base showed that there was a small alteration in the inclination of these teeth soon after the treatment, but the T3 and T4 time points show an increased angle of this inclination. Meanwhile, in Group C, the mean values of these angles at the T1 and T2 time points were close to the initial values found in Group T, and they presented a decrease in the inclination of the upper incisors at the T3 and T4 time points.

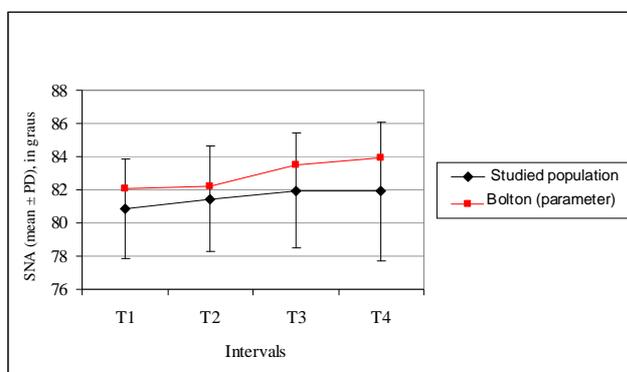


Figure 3 Maxilla anterior-posterior position (SNA), in degrees, according to the time points.

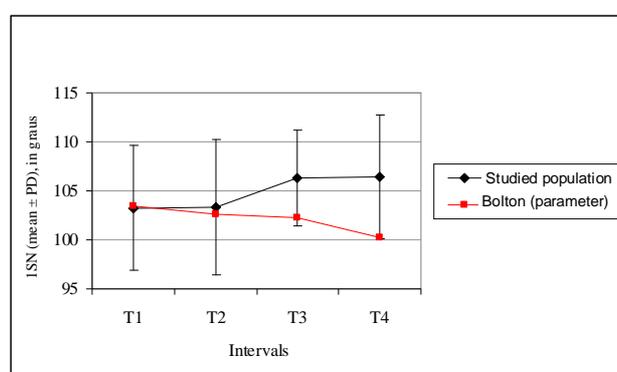


Figure 4 Inclination of the upper incisors in relation to the cranial base (I-SN), in degrees, according to the time points.

The palatal plane presented a clockwise turn after the maxillary expansion, and the difference in the mean values between the T1 and T2 time points was 0.83° , whereas Group C presented no differences in mean values at the same time points. In Group T, these mean values continued to gradually grow while Group C showed an increase only in the T2 to T3 interval. Upon analyzing all the time points for Group T, it was verified that the total sum of the differences between the means was 1.54° , while Group C showed an increase of 1° in the total difference among the means.

Table 2. Descriptive statistic of the palatal plan inclination (SNPP), in degrees, of patients submitted for intervention and the Bolton references, according to the periods of follow-up.

Descriptive Statistics (Group T)	SNPP				Differences in SNPP		
	T1	T2	T3	T4	T2 - T1	T3 - T2	T4 - T3
n	26	27	28	29	24	26	28
Mean	6.85	7.19	7.71	7.97	0.83	0.50	0.21
Standard Deviation	4.66	3.94	3.59	3.55	4.58	2.14	1.85
P-value for the paired t-test					0.382	0.245	0.546
BOLTON (Group C)							
Mean	8.00	8.00	9.00	9.00	0.00	1.00	0.00

*One-sample t test verifying if the mean observed at each time point (or variation) is statistically the same as the Bolton reference.

The anterior-superior (ASFH) and the posterior-superior (PSFH) facial heights are the linear measurements that identify the vertical maxilla position. They presented similar behaviors in both groups, however Group T displayed values higher than those in the Group C population. The differences in the means of Group T at the T1 to T2 time points revealed increases of these heights of 1.83 mm and 1.58 mm, respectively. In Group C, even though there were increases in the mean values at these time points, they were less prominent than those in Group T, at 1.40 mm for the ASFH and at 1.0 mm for the PSFH. The curves presented at the T2 to T3 time points are parallel, indicating similar growth patterns, with mean differences of 4.23 mm for the ASFH and 3.35 mm for the PSFH in Group T, and a mean difference of 4.0 mm for both measures in Group C. From the T3 to the T4 time point, Group T and Group C maintained their growth rates.

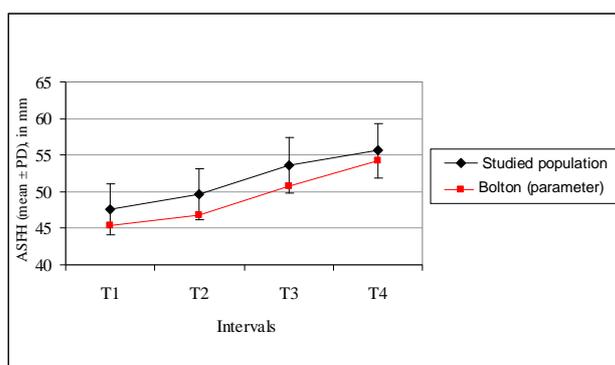


Figure 5. Anterior superior facial height mean (ASFH), in mm, according to the time points.

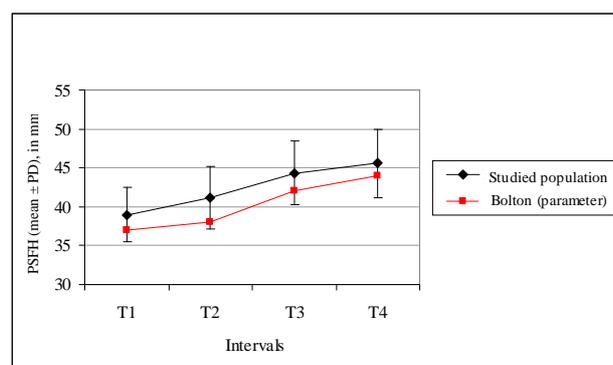


Figure 6 Posterior-superior facial height mean (PSFH), in mm, according to the time points.

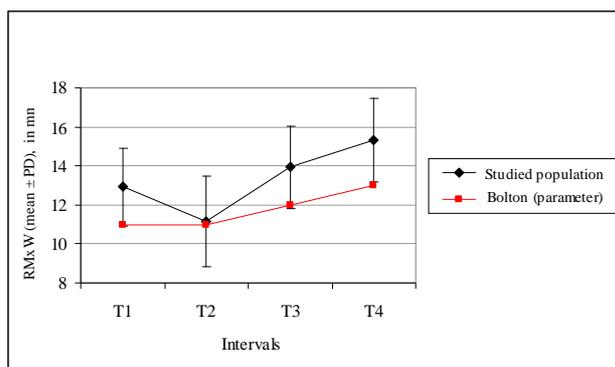


Figure 7. Right Maxilla right width (RMxW), in mm, according to the time points.

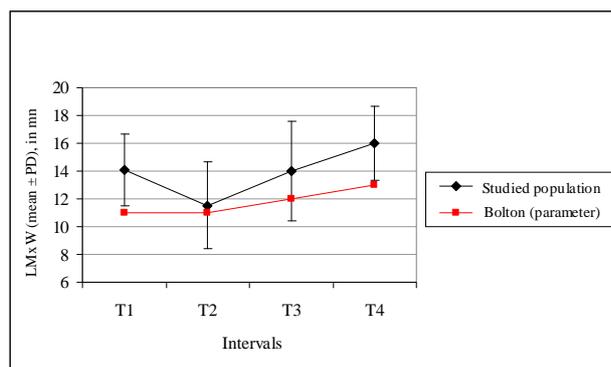


Figure 8. Left Maxilla left width (LMxW), in mm, according to the time points.

The maxilla width growth pattern was similar on both sides, despite different mean values. With the treatment, a decrease in the distance from point J to the outer oblique line was noted, demonstrating an increase in the maxilla width, allowing the Group T values to approach the normal values represented by Group C. At the post-treatment time points, the maxilla transverse growth in Group T was more expressive than the growth in Group C.

The A6-A6 measure represents the distance in millimeters between these points, which are located at the vestibular face of the first upper molars. At the T1 time point, this measure is lower for the mean value in Group T than that in Group C. With the treatment, there is a considerable increase in the values obtained for this measure in Group T, making the difference between the groups significant. At the subsequent time points, the distance between the mentioned points gradually decreased until they were equal to the values obtained for Group C, which was considered as our reference of normality.

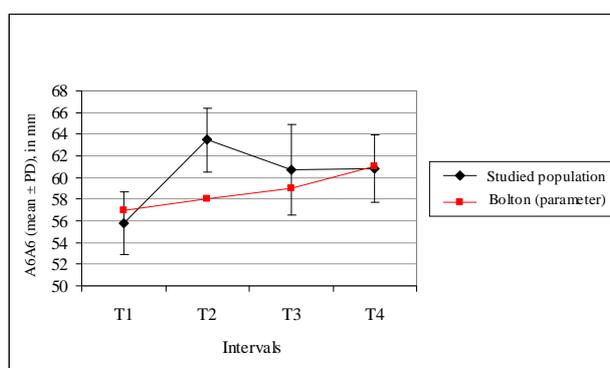


Figure 9 Upper inter-molar distance (A6-A6), in mm, according to the time points.

DISCUSSION

This longitudinal study of the phenomenon of facial growth from mixed to complete permanent dentition included 12 years of observation distributed in the following way: from the time point T1 to T2 (with an interval of 1 year), 4 years from the time point T2 to T3, and 7 years from the time point T3 to T4. The treatment was performed after the T1 time point, at which time the patients average age was 8 years and two months old, which is beneficial for a good skeletal response to the therapy. The group that received treatment did not undergo any other orthodontic intervention, which allowed the exclusive analysis of the effect of rapid maxilla expansion as well as the long term follow-up and growth pattern evaluation of this population.

The vertical and anterior-posterior skeletal alterations observed in this study comprise a slight forward and accentuated downward dislocation of the maxilla after the expansion. In agreement with these findings, Davis and Kronman¹² and Chung and Font¹³ observed a slight forward to downward dislocation of point A was observed immediately after the RME.

In the present study, the maxilla anterior dislocation at the end of the observation period was greater in the control group than in the treated group, with mean values of 1.8° and 1°, respectively. This fact demonstrates that the RME did not greatly influence the maxilla anterior dislocation. In longitudinal study Chang et al¹⁴ confirmed that, in the RME group, the SNA decreased approximately 0.5°, and in the control group it increased approximately 0.5° during the same period. However, the RME was accompanied by an additional orthodontic treatment using the edgewise technique.

Gautam et al⁸ observed that the palatine expansion caused rupture of the median palatine sutures, and a similar effect on the immediate growth was manifested with downward and forward maxillary dislocation. The maxillary rotation in which the anterior nasal spine moved downward more than the posterior nasal spine was evident.

The increase in the maxilla vertical dimension in response to the treatment, in this study, was considerable when compared to the control group. The anterior facial height increased more than the posterior facial height,

confirming the clockwise turn of the palatal plane in both groups. Velazquez et al¹⁵ evaluated the sagittal skeletal alterations three years after the RME. They also confirmed that the maxilla height increased approximately 2.0 mm and that the maxilla presented the clockwise turn, but that there was a subsequent fixed orthodontic treatment that could have influenced the results.

Some cases of anterior crossbite inserted in this study, in spite of the slight advancement of point A, demonstrated the correction of this alteration, which could have been helped by the clockwise turn of the palatal plane. In all of the analyzed periods, the clockwise turn of the palatal plane was greater in the treated group than in the control group; therefore, RME led to growth with a larger increase of the vertical maxilla dimension.

Another aspect that could have helped in the correction of the anterior crossbite was the vestibular inclination of the upper incisors after the treatment. Normally, there is an inclination of these teeth to the palatine, as shown by the control group results.

In relation to the right and left maxillary widths, the decrease of the mean values at the T2 time point in fact represents the real increase of the maxilla (Figure 2, page 20). These measurements, performed in the PA cephalograms, represent the distance between point J and the frontal facial line, located on each side of the face, as the frontal facial line follows the lateral orbital wall until the Ag point. With the treatment, the surrounding structures, which in this case were the structures used to trace the frontal facial line, did not follow the maxilla response at the first time point. At the T3 and T4 time points, the values increased again and even surpassed the initial values as the maxilla was repositioned in the normal relation, thereby allowing normal growth as well as stimulating the surrounding bone structures and favoring the increase of the width of the face.

Cameron et al¹⁶ showed that the changes in the cranial-facial structures far from the nasal-maxillary region in the RME group exceeded those in the control group. They noted significant width increases of the orbital lateral wall, of the large sphenoid ridges and of the maxillary-mandibular width. Moreover, Provatidis et al¹⁷ in a study employing finite elements, observed a minimum

dislocation in the pterygoid processes of the sphenoid bone closer to the cranial base.

These reports help to explain why a decrease of the distance between point J and the frontal facial line occurs after RME. At the end, the structures used to trace the mentioned line are far from the maxillary bones and suffered a minimum dislocation with the therapy; however, they were tensioned by the forces on the maxilla that stimulated the growth of the surrounding bone structures.

The constant increase of the mean maxillary width values in the control group in the present study confirm that, from 8 to 18 years of age, a transverse growth of 2.0 mm occurs on each side, especially at the T3 and T4 time points. Nevertheless, in the group in which RME was performed, the maxillary transverse growth surpassed the control group growth by 0.35 mm on the right side and 0.09 mm on the left side.

It is known that the median palatine suture is greater in the palatal anterior portion with a V-opening pattern, and, according to Davidovitch et al¹⁸, the dental response to RME occurs in the inverted V with a greater dislocation of the first upper molars.

The inter-molar distance in the treated group, in the present study, was initially smaller than that in the control group, which is a characteristic of the posterior crossbite problem in the studied sample. With treatment, as evaluated at the T2 time point, an increase of 8.0 mm in distance was observed due to the dental expansion performed by the Haas maxillary expander. At the T3 time point, five years after the expansion, the inter-molar distance had decreased 2.79 mm, and this distance remained stable until the T4 time point. Lima et al¹⁹ in the model analyses, performed with the same sample as in the present study, observed that the average increase of the inter-molar distance after RME was 5.58 mm for the lingual points and 5.64 mm for the occlusal points. These same values show a significant reduction of 1.13 mm when comparing the post-treatment time points and the short- and long-term follow-up.

The difference in the absolute values presented between the current research and the reports of Lima et al¹⁹ can be explained by the radiographic distortion.

The increased distance between the first upper molars observed by Cameron et al¹⁶ was 3.5 mm, as measured by PA cephalograms. Cross and McDonald²⁰ reported that the upper inter-molar distance in the PA radiographies increased by 5.5 mm. In both studies, this increase should be interpreted as a combination of the results from the RME and the fixed orthodontic therapy.

In the present study, when comparing the increases in the inter-molar distance at the end of the observation period, it was noticed that the treated group exhibited an increase of 5.21 mm and the control group displayed an increase of 4.0 mm. Similar data were collected by Geran et al⁴ ten years after the conclusion of the treatment. They noticed an increase in the inter-molar distance of 4.2 mm for the treated group, which was 3.5 mm higher than that observed in the control group.

CONCLUSION

The rapid maxillary expansion allowed the recovery of the growth pattern and normal maxillary development. There was forward and downward dislocation of the maxilla after the expansion, as well as an increase of the vertical dimension, that evolved into a growth pattern similar to the control group population. There was a real increase in the maxillary width. The inter-molar distance presented increase due to the dental expansion over-correction. In the long-term, there was a decrease of the dental over-correction that permitted the right vestibular-lingual position, with values close to the normality pattern. The upper incisors were inclined to the vestibular, but, with the treatment. They were associated with the maxillary clockwise dislocation and uncrossed the bite in an anterior-posterior direction.

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4.2 ARTIGO 2

Skeletal and dental analysis of the spontaneous response of the mandible to the rapid expansion of the maxilla: a longitudinal study. Estudo Longitudinal. Janaína C. Gomes, Roberto M.A. Lima Filho, Ana Maria Bolognese. American Journal of Orthodontics and Dentofacial Orthopedics.

ABSTRACT

Introduction: The objective of this study was to verify the skeletal effects of early treatment of transverse maxillary deficiency and its influence on the spatial position of the mandible and the lower dental arch. **Methods:** A longitudinal study was performed with 30 Caucasian patients with mixed dentition, Class I malocclusion; 12 patients were male and 18 female, treated only with rapid expansion of the maxilla. A total of 240 lateral and postero-anterior cephalometric radiographs were used. The control group consisted of the average cephalometric values of the “Bolton Standards of Dentofacial Developmental Growth”, which provides data from patients with excellent occlusion. **Results:** The spontaneous responses from group T showed anterior displacement of the mandible. The gonial angle and the mandibular plane decreased with growth, causing a favorable counterclockwise turn of the mandible. The increase in anterior lower facial height at the end of the period of observation was greater in group C than in group T. The posterior inferior facial height was directly related to the mandibular branch length. The vertical growth of the mandible was greater in the posterior region than in the anterior, which favored the reduction of the mandibular plane. The rapid expansion of the maxilla had no effect on the transverse width of the base of the mandible, which probably underwent alterations related to growth. The decrease in the inferior intermolar distance at the end of the study period represented a dental relapse, i.e., the inferior molars practically returned to their initial position. **Conclusions:** According to the results obtained, it can be concluded that rapid maxillary expansion can be used in all patients, even in those who show a vertical growth pattern at the beginning of treatment, because in the long-term, the changes in the vertical plane are within the normal range and also show benefits in the sagittal and transverse planes.

INTRODUCTION

The position of the lower teeth could be influenced more by the skeletal morphology of the maxilla than by the size and shape of the mandible.¹ The primary cause of dental crowding is frequently related to a sagittal or transverse

deficiency of the maxilla. If the position of the upper teeth reflects a skeletal discrepancy, cross bite often occurs. On the other hand, if the maxillary constriction is compensated by the dentition and both dental arches are atretic, dental crowding and absence of cross bite can be observed.

Problems related to negative outcomes of the mandibular dental arch present common limiting factors in clinical practice. True orthopedic expansion of the lower arch is difficult to achieve unless an osteogenic distraction is performed. In the correction of maxillary transverse deficiency, there is expansion of not only the maxillary dental arch but also the lower dental arch. During the increase of mandibular arch width, decompensation primarily occurs; the postero-inferior teeth verticalize because they often erupt with lingual inclination due to the maxillary constriction.²

Rapid maxillary expansion (RME) has benefits not only in the treatment of transverse deficiency of the dental arches, but also in the treatment of sagittal problems. In some patients with mixed dentition that shows moderate skeletal imbalance, simply increasing the width of the maxilla can lead to a spontaneous correction of the anterior cross bite.³

Class II malocclusion is mainly related to problems in the sagittal and vertical directions. Results of the correction of Class II malocclusion after RME in growing patients indicate that many Class II malocclusions have a strong transverse component.⁴ The overcorrection of the maxillary expansion, which is subsequently stabilized with a removable palatal plate, disrupts the occlusion. The patients acquire a mandibular posture that is slightly forward, eliminating the vestibular cross bite tendency with contact from only the lingual cusps of the posterior upper teeth with the vestibular cusps of the posterior lower teeth, simultaneously improving the relationship in the sagittal plane. Thus, there is stimulation of mandibular growth and the initial posture can change permanently. The spontaneous correction of Class II, if it happens, will normally occur during the first 6 to 12 months after RME.⁵

In long-term studies, RME showed no significant effects in the vertical direction, demonstrating that changes observed right after rapid maxillary

expansion tend to recur. This is advantageous because it makes this therapy available to patients with vertical growth patterns.⁶⁻⁹

Therefore, although RME is employed in the treatment of transverse maxillary discrepancy, it also promotes skeletal and dental changes in the mandible. Hence, the objective of this study was to focus three-dimensionally on the skeletal and dental longitudinal aspects of the mandible in Class I patients after treatment of transverse maxillary deficiency with rapid palate disjunction, based on measurements obtained from the profile and postero-anterior cephalometric radiographs. The cephalometric values of the “Bolton Standards of Dentofacial Developmental Growth” were used as a control, according to the average age of patients in each phase of the treatment.

SUBJECTS AND METHODS

This clinical research consisted of a cohort study obtained from the same population. All individuals were seen and treated by a single researcher at the Clínica Lima Ortodontia S/C Ltda., in São José do Rio Preto, SP between 1975 and 1991.

The sample consisted of patients in the initial stage of mixed dentition, presenting Class I with maxillomandibular transverse skeletal discrepancy, real or relative maxillary deficiency and normal or slightly crowded lower arch, not exceeding 1.5 mm of dentoalveolar discrepancy. These inclusion criteria characterize a convenience sample. The patients were exclusively submitted to rapid maxillary expansion using a maxillary bone extensor and following the Haas (1961)¹⁰ protocol, without any subsequent orthodontic therapy.

This study consisted of a longitudinal observation of 30 Caucasian patients in the mixed dentition phase with Class I malocclusion (12 male and 18 female), who comprised the treatment group (T). There were 240 lateral and posterolateral cephalometric radiographs that were used.

All of the documentation was done in the same clinic where the patients were treated, and was carried out before the start of treatment (**T₁**), at short-term follow-up at one year after expansion (**T₂**), to check progress at five years after expansion (**T₃**) and to check long-term outcome at eleven years after

expansion with complete establishment of permanent dentition (**T₄**). All of the procedures for orthodontic documentation followed criteria for standardization and quality control recommended by the *American Board of Orthodontics Dental Cast Guide*.¹¹

The control group (**C**) consisted of the average cephalometric values of the “Bolton Standards of Dentofacial Developmental Growth”, supplying data from patients with excellent occlusion at the ages of 8, 9, 13 and 18 years.

As the study population (**T**) was followed for a long period of time, some radiographs were lost and were not included in the statistical analysis. The average age and number of patients evaluated in each phase of the treatment are shown in Table 1.

Table 1 Age for the assessment phases pre-treatment (**T₁**), short-term follow-up (**T₂**), progress (**T₃**) and long-term (**T₄**).

Groups	T₁ n = 26	T₂ n = 27	T₃ n = 28	T₄ n = 29
Mean age	8y 2m	9y 4m	13y 2m	20y 7m
Range	7y – 9y 10m	7y 8m – 10y 10m	12y 8m – 14y 11m	18y – 23y 9m

y=years; m=months

The expansion screw was activated twice, equivalent to a 2/4 turn or 0.5 mm, right after cementation. Subsequently, those responsible for the patient received instructions about the activation, prophylaxis, possible occurrences throughout the period of suture opening and orientation to turn the screw in the anteroposterior direction, ¼ turn (0.25 mm) in the morning and ¼ at night. The patients were observed weekly, for 3 to 4 weeks.

When the planned expansion was achieved, i.e., ideal overcorrection in all cases with the screw opened at least 7 mm and a maximum of 12 mm, the expander was stabilized with acrylic to avoid its movement during chewing and maintained in place for a period of 6.4 months (3 – 7 months) for retention.

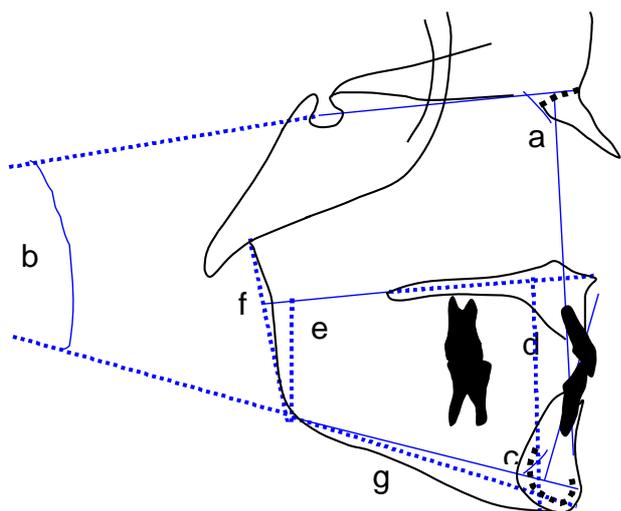


Figure 1 Representation of the angular measurements in the profile cephalograms were SNB (a), GoGnSN (b), GoGn.1 (c), and the linear measurements were LAFH (d), AFPI (e), ArGo (f), GoPog (g).

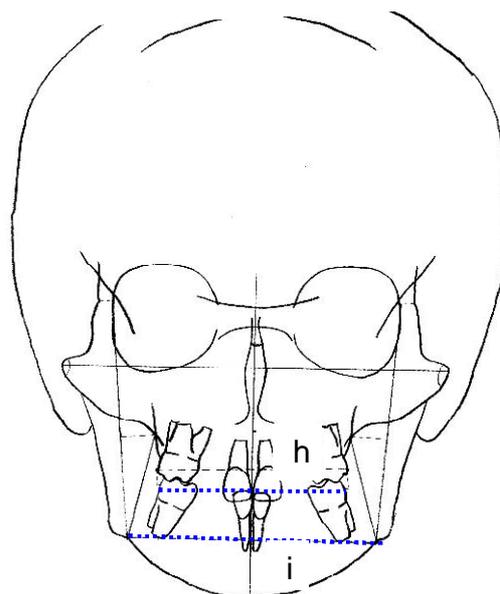


Figure 2 Representation of the linear measurements analyzed in the postero-anterior cephalograms were: LMD (h) and B6B6 (i).

About 2 to 7 days after the removal of the expander, an acrylic removable plate with selective adjustment in the palatal contour, was placed for containment allowing the return of the over-expanded posterior maxillary teeth, as recommended by Haas.³ The usage time of this plate varied, sometimes remaining until the completion of documentation in the short-term follow-up (T₂).

To evaluate the reproducibility of the cephalometric measurements, tests were performed to verify the error in the method employed; the error reached 0.20%.

A comparative method was used, with longitudinal evaluation between the treatment groups at T1-T2, T2-T3 and T3-T4 according to the average age that constituted the sample. A paired Student's t-test was used, with a significance level of $p < 0.05$.

The average values of the control group were compared with the respective average values of the treatment group at each assessment, according to the corresponding ages, and a one-sample t-test with a 5% significance level was used.

RESULTS

The SNB angle, which reflects the anteroposterior behavior of the mandible, revealed that in group T, there was a tendency toward reduced average values after maxillary expansion (Table 2, page, 36). However, from the T2 to T3 assessment there was a statistically significant anterior displacement of the mandible, with differences of 2.31° in the averages. From the T3 to T4 assessment, the anterior displacement of the mandible was less, with differences of 0.61° between the average values.

The vertical alterations in the mandible were measured by the GoGnSN, which showed a slight increase in angulation from the T1 to T2 assessment (35.62° to 35.85°), characterizing a clockwise turn of the mandible. In group C, the average values of this angle did not change from the T1 to T2 assessment. Between the T3 to T2 assessments, the mandible turned anti-clockwise, causing a sharp closure of the mandibular plane, with a statistically significant reduction of -2.27° for group T. In group C there was a similar process, although less expressive, with a -1.4° reduction between the T3 and T4 assessments. However, at the end of the observation period, the total difference between the averages for group T and group C was -2.14° and -2.8° , respectively, indicating a greater closure of the mandibular plane in group C. Group T showed high values of GoGnSN consistent with dolicocephalic patients, unlike group C, which showed values less than 32° consistent with brachycephalic patients. This is why the one-sample t-test showed statistically significant differences for the average values between the groups (Table 3).

Table 2 Descriptive statistics of the antero-posterior position of the mandible (SNB), in degrees, of patients submitted to intervention and references from Bolton, according to the follow-up times.

Descriptive Statistics	SNB				Differences in SNB		
	T1	T2	T3	T4	T2 - T1	T3 - T2	T4 - T3
n	26	27	28	29	25	26	28
Average	77.44	77.44	79.46	80.10	-0.16	2.31	0.61
Standard Deviation	3.15	2.85	2.81	3.75	4.77	1.98	2.48
P-value of the paired t-test					0.868	< 0.001	0.207

BOLTON							
Average	78.60	78.80	80.20	81.20	0.20	1.40	1.00
Standard Deviation	2.63	2.58	2.65	2.63			
P-value of the t-test*	0.068	0.020	0.177	0.127	0.709	0.027	0.410

*T test for one sample (one-sample t test), determining whether the average observed in each follow-up time (or variation) was statistically equal to the reference from Bolton.

Table 3 Descriptive statistics of the mandibular plane (GoGnSN), in degrees, of patients submitted to intervention and references from Bolton, according to the follow-up times.

Descriptive Statistics	GoGnSN				Differences in GoGnSN		
	T1	T2	T3	T4	T2 - T1	T3 - T2	T4 - T3
N	26	27	28	29	24	26	28
Average	35.62	35.85	33.96	33.07	0.92	-2.27	-0.79
Standard Deviation	5.00	4.79	4.48	4.90	2.32	2.68	2.45
P-value of the paired t-test					0.065	< 0.001	0.102
BOLTON							
Average	31.60	31.60	30.20	28.80	0.00	-1.40	-1.40
Standard Deviation	2.94	2.93	3.25	3.57			
P-value of the t-test*	< 0.001	< 0.001	< 0.001	< 0.001	0.065	0.110	0.197

*T test for one sample (*one-sample t test*), determining whether the observed average at each follow-up time (or variation) was statistically equal to the reference from Bolton.

In group T, the mandibular branch increased in height after maxillary expansion, while in group C, the period from T1 to T2 did not show significant alterations. From the T2 to T3 assessment, the mandibular branch showed similar growth patterns in both groups. However, at T4, group C showed greater growth than group T, according to the upward slope of the curves in Figure 2. In summary, throughout the observation period, groups T and C showed mandibular branch growth of 10.42 mm and 11.10 mm, respectively.

Although the length of the body of the mandible in group T was greater than that in group C, both followed the same growth pattern during the entire observation period. In the same manner, the growth of the body of the mandible at the end of the study was 12.91 mm in group T and 12.70 mm in group C.

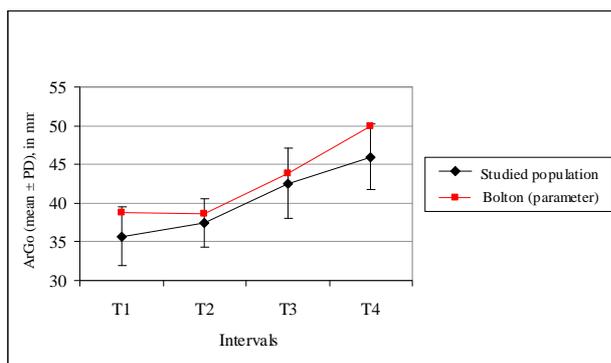


Figure 3 Mandibular branch length (ArGo), in mm, according to follow-up times

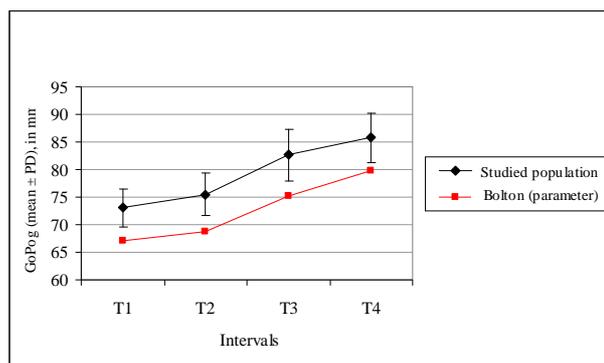


Figure 4 Body of the mandible length (GoPog), in mm, according to follow-up times.

The inclination of lower incisors, represented by the GoGn-1 angle, tended to decrease, indicating that these teeth became more vertical throughout the observation period in both groups.

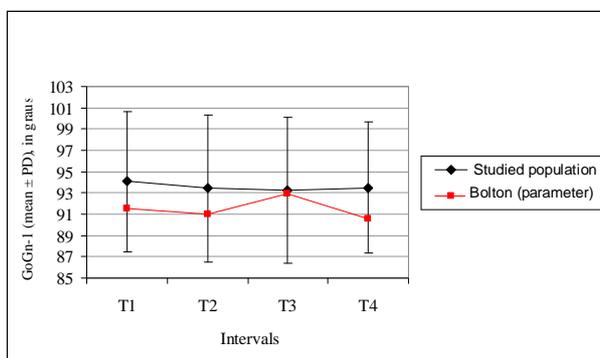


Figure 5 Inclination of lower incisors (GoGn-1), in degrees, according to the follow-up times.

The lower anterior facial height increased on average by 1.38 mm in group T and 0.5 mm in group C, from the T1 to T2 assessment. This increase remained more pronounced in group T, with a statistically significant difference of 5.81 mm, in relation to 4.2 mm in group C. At the T3-T4 assessment, the values approached each other, with groups C and T having an increase in height of 6.5 mm and 3.82 mm, respectively (Figure 6).

The lower posterior facial height showed greater average values in group C than in group T; although, the growth pattern of both groups were similar. Their curves are parallel in Figure 5, except from the T3 to T4 assessment, where group C exhibited a greater increase of LPFH. At the end

of the study, group T had a total increase of 8.73 mm and group C of 9.0 mm for the lower posterior facial height.

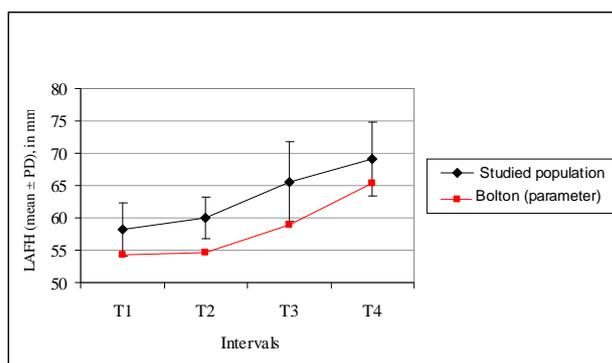


Figure 6 Lower anterior facial height (LAFH), in mm, according to follow-up times.

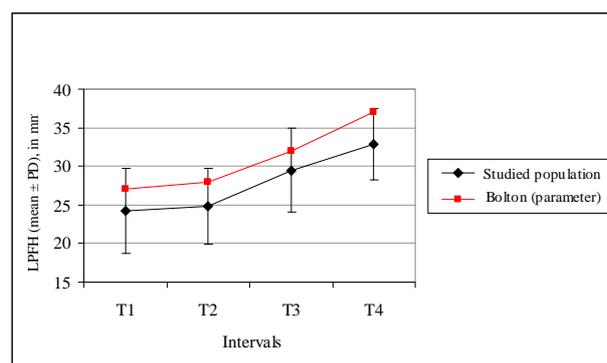


Figure 7 Lower posterior facial height (LPFH), in mm, according to follow-up times

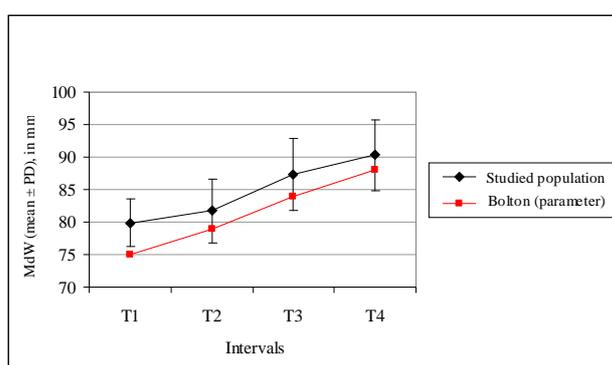


Figure 8 Mandibular width (LMd), in mm, according to the follow-up times

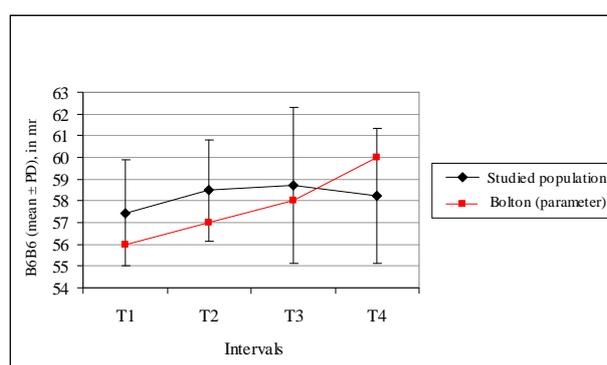


Figure 9 Lower inter-molar distance (B6-B6), in mm, according to the follow-up times.

After maxillary expansion, group T showed a small increase in the width of the mandibular base when compared to group C, with values of 1.67 mm and 4.00 mm, respectively. At subsequent timepoints, the enlargement of the mandible was considerable in both groups, but at the end of the follow-up period, group C showed a total increase of 13.0 mm; in group T this increase was only 10.59 mm (Figure 8, page 38).

Representing the distance between the most prominent points of the vestibular crown of the first lower molars, the B6-B6 measurement reflects the response of these teeth, transversely, to the maxillary expansion. The results show that the mandibular width of group T is greater than that of group C, and the distance between the B6 points is also greater. In group T, the graph curve starts a trajectory that shows an increase in the B6-B6 distance until T2 that is compatible with the increase that occurs in group C. Nevertheless, coinciding

with the period of removal of the containment apparatus, there is a decrease in the B6-B6 distance in group T; while in group C, the period of greatest increase of this distance was from the T3 assessment. In summary, the total increase in B6-B6 distance was 0.78 mm in group T and 4.0 mm for group C, showing a statistically significant difference.

DISCUSSION

In this study, Group T received only rapid maxillary expansion as a treatment; this patient population with specific inclusion criteria reached excellent occlusion after treatment that remained throughout the observation period.

The tendency of growth displacement down and forward is consistent with dolicocephalic patients with characteristics of a long and narrow face; these patients show a greater incidence of maxillary atresia for this reason. The patients from the study sample (group T) showed a vertical growth pattern with average values of approximately 35° ($PD=5^{\circ}$) for the mandibular plane angle at T1. This characterized the patients as a dolicocephalic sample, which would contraindicate maxillary expansion treatment for this group. However, when observing the average values in the short-term and long-term follow-ups, it can be seen that the expansion caused an anti-clockwise turn of the mandible, favoring the normal development of patients in the treatment group.

According to Garib et al⁹, the vertical alterations observed right after rapid maxillary expansion are temporary phenomena and are not required precautions, when employing this procedure in patients with a predominantly vertical growth pattern.

The results of this study reveal a considerable increase in all of the structural and spatial measurements related to the mandible in both groups after the T2 assessment. The group T population showed a mandibular growth pattern similar to that of group C, although the average values of group T were greater than those of group C in the majority of measurements. In summary, the mandibular alterations were not caused by RME, but the correction of the

transverse deficiency of the maxilla contributed to the resumption of the normal growth pattern of the mandible.

In this study, the increase in the lower anterior facial height of the treatment group at the T2 assessment could be related to the clockwise turn of the mandible, as in group C there was no increase in this measurement. Although the treated patients showed tendencies for vertical facial growth, the increase in LAFH at the end of the observation period was greater than that in group C. Therefore, there was an increase in mandibular plane that right after RME. However, short-term observations registered a reduction of this plane.

In agreement with the findings of this study at the T2 assessment, Chung and Font¹² observed a clockwise rotation of the mandible and significant increase in anterior facial height, right after rapid maxillary expansion.

At three years after ERM, Velazquez et al⁷ showed that at the end of the study period, the vertical dimensions tended to return to the existing values before treatment or became smaller, even in patients with a vertical pattern. There was a reduction of the mandibular plane angle, and facial depth increased due to mandibular advance.

Rapid maxillary expansion did not affect the transverse width of the mandibular base. The basal width of the mandible increased in a similar manner in both groups throughout the study period, which had changes related to growth. Korn and Baumrind¹³ reported that the transverse increase in the body of the mandible occurred during growth, via modifications in the mandible sinfise. The different findings of Huertas and Ghafari¹⁴ showed linear regressions between the points Ag, revealing decreased in the basal width of the mandible for the control and treatment groups.

This study showed that as the mandible turned anti-clockwise and was displaced forwards and upwards, the position of the lower incisors was compensated, leaning towards the lingual. In both groups, there was verticalization of the lower incisors, with averages of -1.67 and 0.9 mm for groups T and C, respectively. In group T, there was greater lingual inclination of the incisors from the T1 to T2 assessment and in group C this change occurred from the T3 to T4 assessment. Thus, in group T, the greatest compensation of

the lower incisors occurred after RME, whereas in group C, it was during mandibular growth.

The lower inter-molar distance increased in the intervals T1-T2 and T2-T3, but decreased in the interval T3-T4, showing an increase of only 0.78 mm at the end of the study period; this indicates the verticalization of the lower molars. In group C, this distance increased by 4.0 mm throughout the observation period, with a sharp increase between the T3 and T4 assessments.

According to Hass^{10,15}, the increase of the vestibular inclination of the lower molars was probably due to a combination of factors; the occlusion forces were altered by the expansion, this resulted in a change in equilibrium between the tongue and the perioral musculature. There was also the possibility that the thickness of the apparatus caused a downward displacement of the tongue during habitual maximum intercuspals, thereby increasing the lateral forces on the lower teeth.

A longitudinal investigation using the same sample from this study but evaluating the models indicated spontaneous changes of the dimensions of the mandibular arch.² After RME, there was a significant increase of 0.97 mm in the inter-molar width, measured at points located on the lingual surface of these teeth. In the inter-molar width, measured at points located in the occlusal surface, the increase was 1.47 mm; these findings suggest a slight verticalization of the lower molars.

CONCLUSION

There was anterior displacement of point B by the growth of the body of the mandible as well as an increase in the lower posterior facial height due to the growth of the mandibular branch causing an anti-clockwise turn of the mandible, similar to control group. The rapid maxillary expansion did not affect the transverse width of the mandibular base, which underwent changes related to growth. The increase in inter-molar distance at the end of the study period indicated verticalization of the lower molars. The lower incisors showed alterations in the axial inclination to lingual. The patients from the study sample showed a vertical growth pattern at the start of treatment, indicating a

dolicocephalic sample. In the long-term, the vertical alterations caused by RME did not harm the patients, as they were close to the values found in the control group.

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4.3 ARTIGO 3

Long-term effects of rapid maxillary expansion on nasal cavity width.

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Journal of Anatomy.

ABSTRACT

Considering the strong relationship of maxillary bones to nasal structures, this study aims to verify, tridimensionally, skeletal alterations in the treatment of transverse maxillary deficiency with rapid maxillary expansion, in a long-term analysis of the effects of such treatment on nasal cavity width. A longitudinal study was conducted using 120 anteroposterior cephalometric radiographs from 30 Caucasian patients (12 males and 18 females) presenting malocclusion Class I who were treated only with rapid maxillary expansion. The radiographs were taken during the mixed dentition phase. The control group was represented by cephalometric mean values of Bolton Standards of Dentofacial Developmental Growth, which provides data from patients with excellent occlusion. In relation to maxillary width, the decrease of mean values at time T1 refers to actual increase in maxilla width. Immediately following treatment, the group receiving treatment presented a more pronounced transverse maxillary growth than the control group. The nasal width presented an increase of 2.33 mm after intervention with maxillary expansion and continued with increases of 1.69 mm at time T3 and 1.96 mm at time T4. These results show that increases in maxillary width occurred both immediately after treatment and in the long term. The group that received treatment showed a more evident transverse maxillary growth in comparison with the control group. Nasal width also presented a statistically significant increase after treatment, showing a progressive increase due to growth, however in quantities less evident than after the rapid maxillary expansion.

INTRODUCTION

The nasal cavity is specifically designed to condition and prepare air that reaches the lungs by humidification, temperature adjustment and removal of infections and particulate impurities. Nasal breathing contributes to the ideal development of the nasomaxillary complex. The maxillary bones constitute the floor of the nasal cavity; during growth, the air passing through the nose induces maxillary bone remodeling, with absorption in the floor and lateral walls of the nasal cavity and the development of apposition in the vaulted palate.

Rapid maxillary expansion (RME) is a known and recommended therapy for treatment of constricted maxillary arches; it is preferably applied in patients still in the growing phase. Several studies have asserted that, due to the intimate relationship of maxillary bones to the anatomical structures of the nasal cavity, expansion of the median palatine suture may affect the anatomy and physiology of this cavity.

One of the greatest researchers on RME, Haas (1965) observed that with the opening of the median palatine suture, the central incisors began separation without application of direct force. Separation between the central incisors extended upwards to the nasal cavity. The opening in the suture was shown to be triangular, with a greater expansion in the median alveolar point and closest to the nasal cavity apex. With separation of the maxillary bones, the external walls of the nasal cavity moved laterally. The nasal floor lowered, the alveolar process tilted laterally, and the free margins of the horizontal palatine process moved inferiorly. The overall effect was an increase in respiratory capacity, with the mechanism of nasal enlargement allowing for easier nasal breathing.

Recent studies, such as that of Garret et al. (2008), evaluated the skeletal response in the transverse plane immediately after RME through cone beam computed tomography and affirmed that RME produced a statistically significant increase in nasal width and a decrease in maxillary sinus width. The expansion of the nasal floor represented 31% of the total expansion. Increase in the nasal volume led to reduction in airway resistance and improved airflow.

Given the strong relationship of maxillary bones to nasal structures, this study aims to verify, tridimensionally, the effects of treatment of transverse maxillary deficiency with rapid maxillary expansion by means of a long-term analysis of alterations in nasal width resulting from this therapy.

MATERIALS AND METHODS

The present clinical research consisted of a cohort study of a single population. All individuals were treated by a single researcher at Clínica Lima

Ortodontia S/C Ltda, in São José of Rio Preto city, SP, between 1975 and 1991.

The sample consisted of patients in mixed dentition phase, presenting Class I with transverse maxillary-mandibular skeletal discrepancy, real or relative maxillary deficiency, and lower arch with normal or slight crowding, not exceeding 1.5 mm of dentoalveolar discrepancy. These inclusive criteria characterized a convenience sample. The patients were submitted exclusively to rapid maxillary expansion using an expander with basal support on the maxillary bone and following Haas (1961) protocol, without any subsequent orthodontic therapy.

This research consisted of a longitudinal observation of 120 anteroposterior cephalometric radiographies from 30 Caucasian patients (12 males and 18 females) in mixed dentition phase presenting Class I malocclusion that composed the treated group (**T**).

All documentation was performed in the same clinic in which the patients were treated. The first radiograph was prepared before the beginning of the treatment (**T₁**); short-term monitoring (**T₂**) occurred one year after expansion; progress (**T₃**) was measured five years after expansion, and long-term (**T₄**) eleven years after expansion, when the patient had established permanent dentition.

The control group (**C**) was represented by the cephalometric mean values of “Bolton Standards of Dentofacial Developmental Growth”, providing data of patients with excellent occlusion at the ages of 8, 9, 13 and 18 years old.

Due to the long-term monitoring of the studied population (**T**), some radiographs were lost and were not included in the statistical analysis. The mean age and number of patients assessed in each treatment phase are presented in Table 1.

Table 1 Ages at evaluation phase pre-treatment (**T₁**), short-term monitoring (**T₂**), progress (**T₃**) and long-term (**T₄**).

Groups	T₁ n = 26	T₂ n = 27	T₃ n = 28	T₄ n = 29
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Mean age	8 y 2m	9 y 4m	13 y 2m	20 y 7m
Amplitude	7 y – 9 y 10m	7 y 8m – 10 y 10m	12 y 8m – 14 y 11m	18 y – 23 y 9m

y=years; m=months

The expansion screw was activated twice directly after cementing, equivalent to 2/4 turn of 0.5 mm. Afterwards, those responsible for the patient were instructed in activation, prophylaxis, possible occurrences during the period of suture opening and were directed to activate the screw in the anteroposterior direction by ¼ of a turn (0.25 mm) in the morning and ¼ at night. The patients were monitored weekly over a 3 to 4 week period.

When the planned expansion was reached, that is, when ideal overcorrection had occurred with the screw opened to a minimum of 7 mm and a maximum of 12 mm, the expander was established using acrylic to avoid movement during chewing. The cemented expander was held in position for an average of 6.4 months (3-7 months) for retention.

Approximately 2 to 7 days after removal of the expander, a removable acrylic plate with selective adjustment in the palatine contour was placed as a restrainer, allowing the return of the over-expanded posterior maxillary teeth, as proposed by Hass (1970). The period for usage of this plate varied; in some cases, it remained until documentation at the short-term monitoring point (T_2).

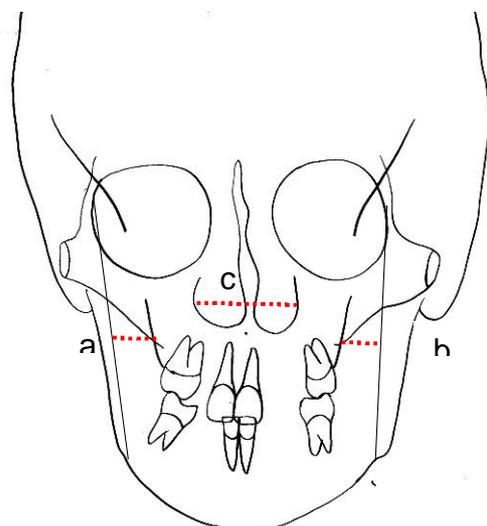


Figure 1 Representation of the linear measures analyzed in the anterior posterior cephalograms were as follows: RMxW (a), LMxW (b), and NWs (c).

To assess the reproducibility of the cephalometric measures, tests were performed to verify errors in the method employed, which reached 0.20%.

To analyze maxillary and nasal cavity behavior according to the mean age that constituted the samples, a comparative method was used, with longitudinal evaluation between the treated groups at T1-T2, T2-T3, and T3-T4. The paired Student's t-test was performed with significance level of $p < 0.05$. The mean values of the control group at each stage were compared with the respective mean values of the treated group, according to their corresponding ages. The one-sample t-test was applied with a significance level of 5%.

RESULTS

Nasal width (NW) showed a statistically significant increase of 2.33 mm after intervention with maxillary expansion. In the subsequent time intervals, there were additional increases in the nasal width of 1.69 mm at T3 and 1.96 mm at T4.

Table 2 Descriptive statistics of nasal width (NW), in mm, of intervention patients at each monitoring interval.

Descriptive Statistic	NW				Differences in NW		
	T1	T2	T3	T4	T2 - T1	T3 - T2	T4 - T3
n	22	25	26	25	21	24	24
Mean	27.84	29.90	31.65	33.56	2.33	1.69	1.96
Standard- deviation	2.20	2.47	3.76	3.16	1.63	2.34	2.99
P-value of paired t test					< 0.001	0.002	0.004

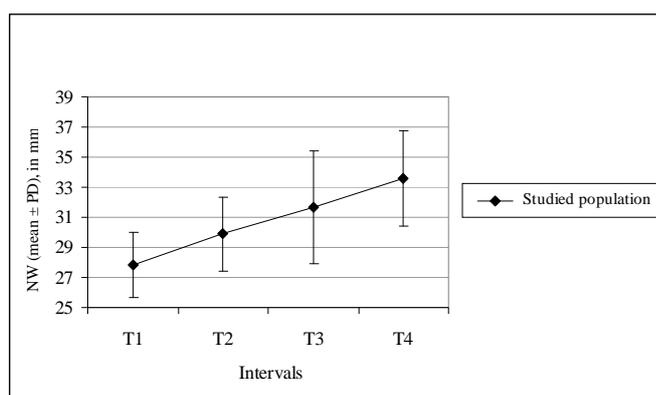


Figure 2 Mean nasal width (NW), in mm, at each monitoring interval.

The modifications in the transverse direction of the maxilla are represented by the linear measures of RMxW and LMxW. The standard growth of the maxilla, in width, was similar on both sides although the mean values are different. With treatment, decreases in the mean values that correspond to maxilla width occurred, and the values of group T approached the normal values represented by group C. In the interval following treatment, transverse maxillary growth was more pronounced in the treated group than in the control group.

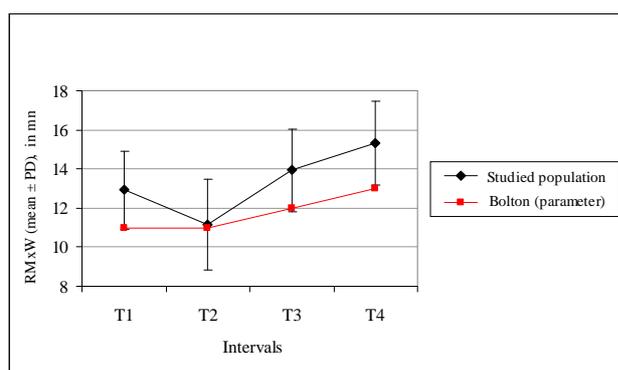


Figure 3 Mean of right maxillary width (RMxW) in mm at each monitored interval.

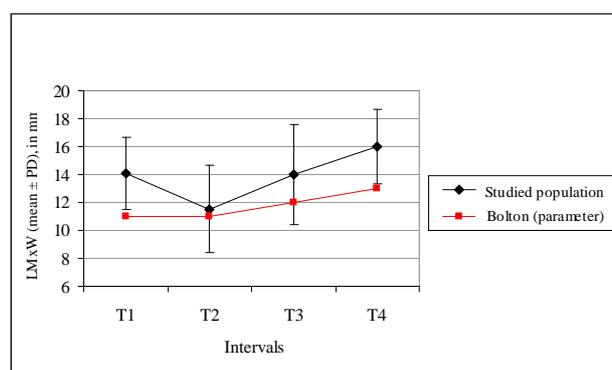


Figure 4 Mean of left maxillary width (LMxW) in mm at each monitored interval.

DISCUSSION

In this study, Group T received only rapid maxillary expansion as a treatment; this patient population with specific inclusion criteria reached excellent occlusion after treatment that remained throughout the observation period.

The longitudinal study of the facial growth phenomenon from mixed dentition to permanent complete dentition involved 12 years of observation as follows: T1 to T2 involved a time interval of 1 year, T2 to T3 an interval of four years, and T3 to T4 an interval of seven years. The treatment was performed just after T1, at which time the mean age of the patients was 8 years old and two months, favoring a good skeletal response to the therapy.

Decrease of right and left maxillary width mean values at T2 actually signifies a real increase of maxilla width (Figure 1, page 48). These measurements, performed in the PA cephalograms, represent the distance

between the points J and the frontal facial line, located on each side of the face where the frontal facial line follows the orbit lateral wall to the Ag point. When the treatment was performed, the surrounding structures, in this case structures used to draw the frontal facial line, did not accompany the maxilla response in the first time. At intervals T3 and T4, the values increased again, surpassing the initial values, since the maxilla was placed in normal relation, also stimulating the surrounding bone structures and favoring width increase in the face.

Similar results showed that modifications of the cranial-facial structures far from the nasomaxillary region in the RME group exceeded those in the control group, presenting significant increases in the width of orbit lateral wall of the greater wings of sphenoid and in maxillomandibular width (Cameron et al. 2002). Moreover, studies with information on development of craniofacial models of finite elements showed that minimal displacement was observed in the pterygoid processes of sphenoid bone, which approached the cranial base (Provatidis et al. 2008).

These reports help to explain why a decrease in the distance between point J and frontal facial line occurs after RME. Though the structures used to draw the referred line are distant from the maxilla bones and suffered minimal displacement with the therapy, they did undergo tension from the forces exerted on the maxilla, stimulating the growth of the surrounding bony structures.

The constant increase in mean values of maxillary width in the control group confirmed that from 8 to 18 years of age, growth occurred in a transverse direction of 2.0 mm on each side, particularly in the intervals T3 and T4. However, in the group in which RME was performed, the transverse maxillary growth surpassed that of the control group by 0.35 mm on the right side and 0.09 mm on the left side.

In this study, nasal width was not compared with group C since the cephalograms of "Bolton Standards of Dentofacial Developmental Growth" did not present the outlines of the lateral wall of the nasal cavity, but group T presented a significant increase in nasal cavity width. Corroborating these

results, Chung & Font (2004) reported a significant increase in the maxillary and nasal cavity widths directly after rapid maxillary expansion.

When analyzing the rapid expansion of dental arches and of nasal cavity through opening of the median palatine suture, one of the most interesting findings of the study performed by Hass (1961) was the simplicity of an extent to which this suture can be opened in the complete absence of pain. Through the opening of the palatine suture, the increase in the final width of the arch was permanent and can be guaranteed by the rapid deposition of the new bone.

Measures and observations performed using different operating methods in animals and clinics indicated that with the opening of the screw, the first reaction was the inclination of the alveolar process, accompanied by the gradual opening of the median palatine suture. The palatine processes of the maxilla begin to move downwards in its free margins causing the lowering of the palatal vault. Clinical findings in the PA cephalometric analysis showed that for an opening of 8 mm in the palatine suture, there was an increase in nasal width of 4.5 mm (Haas 1961, 1965).

In the present study, the nasal width (NW) presented a statistically significant increase in width of 2.33 mm after maxillary expansion intervention, signifying that during a time interval of only one year there was significant increase in the nasal cavity. During the subsequent intervals of time, there was a continuous increase in the nasal width of 1.69 mm at T3 and 1.96 mm at T4; these increases are related to growth and occurred during 4 and 7 year intervals, respectively.

Oliveira de Felipe et al. (2008) found anatomical and physiological modifications in the nasal cavity after RME; however, these modifications are not related to changes in breathing. According to the authors, mouth breathing is a highly complex phenomenon and should not be considered as simple. The increase, statistically significant, in the palatal area during the active expansion phase could be explained by the drastic change in the palate architecture. The separation in the base of the maxilla resulted in a parallel configuration of the palatine processes after treatment. Nasal volume increased significantly

between intervals T1 and T2, remained stable in T3 and significantly increased again until T4.

Using conventional tomography Palaisa et al. (2007) observed significant increases in total volume of the nasal cavity and reduction of resistance in the airways after RME. The area and volume of the median and posterior portions of the nasal cavity increased more than those of the anterior portion, although separation of the intermaxillary suture using RME decreased in the posterior direction.

RME did not interfere with oropharynx width, tongue length, or length and position of hyoid bone, with the exception of the length of airways, according to studies performed by Markoç et al. (2007). Expansion was particularly effective with the increase in the size and width of nasal cavity. RME alone is not useful in individuals presenting turbinate hypertrophy, nasal polyps, hypertrophic adenoid tissues or septum deviation. Nasal resistance decreased and breathing area increased in the group treated with RME.

CONCLUSIONS

According to the observed results, it can be concluded that an increase in the maxillary width occurred immediately after RME treatment. In the long term, width of growth of the maxilla in the group that received treatment was more evident than growth in the control group.

Nasal width presented a statistically significant increase after intervention of maxillary expansion. At subsequent intervals, there was a continuous increase in the nasal width due to growth, although the increase was less pronounced than after RME.

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5 DISCUSSÃO

O grupo que recebeu tratamento, não foi submetido a nenhuma outra intervenção ortodôntica, permitindo a análise exclusiva dos efeitos da ERM e o acompanhamento, a longo prazo, do padrão de crescimento desta população.

O estudo longitudinal para o fenômeno do crescimento facial da dentição mista à dentição permanente completa, compreendeu 12 anos de observação, assim distribuídos: do período T1 para T2 o intervalo de tempo foi de 1 ano, sendo de 4 anos do período T2 para o T3 e de T4 para T3 foi de 7 anos. O tratamento foi realizado após a fase T1, onde a média de idade dos pacientes foi de 8 anos e dois meses, favorecendo boa resposta esquelética à terapia.

As alterações esqueléticas verticais e anteroposteriores na maxila, observadas neste estudo, compreenderam suave deslocamento para frente e acentuado deslocamento para baixo da maxila após a expansão. Concordando com estes achados Davis e Kronman (1969), Chung e Font (2004) observaram que o ponto A foi deslocado para frente logo após ERM.

O deslocamento anterior da maxila, ao final do período de observação, foi maior no grupo controle que no grupo tratado, com valores médios de $1,8^\circ$ e 1° . Este fato mostrou que ERM não teve grande influência no deslocamento anterior da maxila. Em estudo longitudinal, Chang, McNamara et al. (1997) constataram que, no grupo com ERM, o SNA diminuiu aproximadamente $0,5^\circ$ e no grupo controle aumentou aproximadamente $0,5^\circ$ durante o mesmo período. Porém, a ERM foi acompanhada de tratamento ortodôntico pela técnica *edge-wise*.

Gautam, Valiathan and Adhikari (2007) observaram que a expansão palatina causou rompimento das suturas palatinas medianas e efeito semelhante ao crescimento imediato foi manifestado com deslocamento para baixo e para frente da maxila.

O aumento na dimensão vertical da maxila em resposta ao tratamento foi considerável quando comparado ao grupo controle. A altura facial anterior aumentou mais que a altura facial posterior, confirmando o giro horário do plano palatal, em ambos os grupos. Velazquez et al. (1996) avaliaram as alterações esqueléticas sagitais, três anos após ERM. Eles confirmaram que a altura maxilar aumentou aproximadamente 2,0mm e que a maxila apresentou giro no sentido horário, entretanto houve tratamento ortodôntico fixo subsequente, que pode ter influenciado nos resultados.

A tendência de deslocamento do crescimento para baixo e para frente é própria dos pacientes dolicocefálicos, com características de face longa e estreita, que por esta razão, eles apresentam maior incidência de atresia maxilar. Os pacientes da amostra estudada (grupo T) apresentavam padrão de

crescimento vertical com valores médios do ângulo do plano mandibular de aproximadamente 35° ($DP=5^{\circ}$) ao início do tratamento, caracterizando amostra dolicocefálica, o que contra-indicaria a ERM para este grupo. Entretanto, os valores médios no acompanhamento a curto e longo prazo mostraram que a expansão proporcionou o giro da mandíbula no sentido anti-horário, favorecendo o desenvolvimento normal dos pacientes do grupo tratado.

A população do grupo T mostrou padrão de crescimento mandibular semelhante à amostra do grupo C, embora os valores médios do grupo T sejam maiores que os do grupo C, na maioria das medidas. Portanto, a correção da deficiência transversa da maxila colaborou para retomada do padrão de crescimento normal da mandíbula.

No presente estudo o aumento da AFAI do grupo tratado no período T2 pode estar relacionado com o giro da mandíbula no sentido horário, pois o grupo C mostrou que, normalmente, nesta fase não há aumento desta medida. Embora os pacientes tratados apresentassem tendência ao crescimento vertical da face, o aumento da AFAI ao final do período de observação foi maior no grupo C. Os resultados confirmam que, logo após a ERM, ocorreu aumento do plano mandibular. No entanto, as observações em curto prazo registraram diminuição deste plano.

Concordando com os achados deste estudo na fase T2, Chung e Font (2004) observaram que houve rotação da mandíbula no sentido horário e aumento significativo na altura facial anterior, logo após ERM.

Três anos após ERM, Velazquez, Benito *et al.* (1996) mostraram que, ao final do período estudado, as dimensões verticais tenderam a retornar aos

valores existentes antes do tratamento ou ficarem menores, mesmo em pacientes com padrão vertical. Houve diminuição do ângulo do plano mandibular e a profundidade facial aumentou devido ao avanço da mandíbula.

Alguns casos de mordida cruzada anterior estavam inseridos neste estudo e, apesar do suave avanço do ponto A, ocorreu correção desta alteração, que pode ter sido influenciada pelo giro do plano palatal no sentido horário, que proporcionou aumento da dimensão vertical da maxila. Em todos os períodos analisados o giro horário do plano palatal foi maior no grupo tratado do que no grupo controle, portanto pode-se dizer que a ERM conduziu ao crescimento com maior aumento da dimensão vertical na maxila.

Outro fato que pode ter auxiliado na correção da mordida cruzada anterior foi à inclinação, para vestibular, dos incisivos superiores após o tratamento. Normalmente, ocorre inclinação para palatina destes dentes, como revelaram os resultados do grupo controle.

O presente estudo mostrou que os incisivos inferiores tiveram compensação de sua posição, inclinando-se para lingual à medida que ocorreu o giro da mandíbula no sentido anti-horário e seu deslocamento para frente e para cima. Em ambos os grupos houve verticalização dos incisivos inferiores, sendo que a média total para o grupo T foi de -1,67mm e no C foi de -0,9mm. No grupo T ocorreu maior inclinação lingual dos incisivos nos intervalos T1 para T2 e no grupo C foi nos intervalos T3 para T4. Com isso, pode ser afirmado que no grupo T a maior compensação dos incisivos inferiores ocorreu após ERM e no grupo C foi durante o crescimento da mandíbula.

Em relação à largura maxilar direita e esquerda, a diminuição dos valores médios na fase T2, na verdade, significaram o aumento real na largura da maxila (Figura 4, página 12). Estas medidas, realizadas nos cefalogramas PA, representaram a distância entre os pontos J e a linha facial frontal, localizada em cada lado da face, sendo que a linha facial frontal tange a parede lateral da órbita até o ponto Ag. Quando houve o tratamento, as estruturas vizinhas, no caso as estruturas utilizadas para traçar a linha facial frontal, não acompanharam a resposta da maxila, no primeiro momento. Nos períodos T3 e T4 os valores voltaram a aumentar e até ultrapassaram os valores iniciais, pois a maxila estabeleceu relação normal favorecendo o crescimento normal. Desta forma, houve o estímulo para crescimento das estruturas ósseas vizinhas, proporcionando o aumento em largura da face.

Cameron, Franchi *et al.* (2002) mostraram que as modificações nas estruturas crâniofacial distantes da região nasomaxilar, no grupo da ERM excederam as do grupo controle, com aumentos significativos na largura da parede lateral da órbita, das grandes asas do esfenóide e na largura maxilomandibular. Além disso, Provatidis, Georgiopoulos *et al.* (2008), em estudo com elementos finitos, perceberam que o deslocamento mínimo ocorreu nos processos pterigóides do osso esfenóide que se aproximavam da base craniana. Estes relatos ajudam a explicar, porque ocorreu diminuição da distância entre o ponto J e a linha facial frontal, após ERM. Afinal, as estruturas utilizadas para traçar a referida linha são distantes dos ossos da maxila e sofreram deslocamento mínimo com a terapia, contudo, receberam

tensões provenientes das forças exercidas sobre a maxila, que estimularam o crescimento das estruturas ósseas circundantes.

O aumento constante dos valores médios da largura maxilar no grupo controle do presente estudo confirmam, que dos 8 aos 18 anos, ocorreu crescimento no sentido transversal de 2,0mm em cada lado, especialmente, nos intervalos T3 e T4. Entretanto, no grupo que foi realizada a ERM o crescimento transversal da maxila superou o do grupo controle em 0,35 mm do lado direito e em 0,09 mm do lado esquerdo.

A ERM não apresentou efeito sobre a largura transversal da base óssea mandibular. O aumento desta dimensão, registrado neste estudo, ocorreu de modo semelhante em ambos os grupos, ao longo de todo período, configurando alterações relativas ao crescimento. Korn e Baumrind (1990) informaram que o aumento transversal no corpo da mandíbula ocorreu durante crescimento, por modificações na sínfise mandibular.

Distinto resultado foi levantado por Huertas e Ghafari (2001), que apontaram regressões lineares entre os pontos Ag, revelando diminuição na largura basal da mandíbula para os grupos controle e tratado.

Sabe-se que a resposta da sutura palatina mediana foi maior na porção anterior do palato com padrão de abertura em V e segundo Davidovitch, Efstathiou *et al.* (2005) a resposta dentária a ERM ocorre em V invertido com maior deslocamento dos primeiros molares superiores.

No período T1, a distância inter-molares superiores no grupo tratado foi menor que a distância inter-molares inferiores, característica do problema da mordida cruzada posterior dentária. Com o tratamento, no período T2, ocorreu

aumento de 8,0mm na distância inter-molares superiores, devido à expansão dentária realizada pelo expansor maxilar de Haas. No período T3, cinco anos após expansão, a distância inter-molares superiores diminuiu para 2,79mm, mantendo-se estável até o período T4.

À distância inter-molares inferiores aumentou nos intervalos T1-T2 e T2-T3, porém diminuiu no intervalo T3-T4, mostrando ao final do período estudado aumento de apenas 0,78mm, que caracterizou verticalização dos molares inferiores. No grupo C, esta distância aumentou 4,0mm ao longo de todo período de observação, com acentuado aumento entre os momentos T3 e T4.

Lima *et al.* (2005) nas análises dos modelos, realizadas com a mesma amostra do presente estudo, observou que o aumento médio da distância inter-molares superiores após ERM foi de 5,58 mm nos pontos linguais e 5,64 mm para os oclusais. Estes mesmos valores mostraram redução significativa de 1,13 mm ao comparar os momentos pós-tratamento e acompanhamento a curto e longo prazo.

A diferença nos valores absolutos entre a pesquisa atual e os relatos de Lima et al. (2005) podem ser explicados pela distorção radiográfica.

Investigação longitudinal, utilizando à mesma amostra deste estudo, porém avaliando os modelos, indicaram mudanças espontâneas nas dimensões do arco dentário mandibular, em estudo conduzido por Lima *et al.* em 2004. Após a ERM houve aumento significativo de 0.97 mm na largura inter-molares inferiores, medida por pontos localizados na face lingual destes dentes. Nos pontos localizados na superfície oclusal, o aumento foi de 1.47

mm. Ambos resultados sugerem uma leve verticalização dos molares inferiores.

No presente estudo, quando comparou o aumento na distância intermolares superiores ao final do período de observação, foi notado que o grupo tratado obteve acréscimo de 5,21mm e que no grupo controle foi de 4,0mm. Dados semelhantes foram levantados por Geran et al. (2006) 10 anos após conclusão do tratamento. Eles perceberam aumento na distância intermolares de 4,2mm para o grupo tratado, que foi 3,5 mm maior que no grupo controle.

Segundo Haas (1961, 1965) o aumento da inclinação vestibular dos molares inferiores foi, provavelmente, devido à combinação de fatores: as forças da oclusão foram alteradas pela expansão. Isto resultou na mudança de equilíbrio entre a língua e a musculatura peribucal. Houve, também, a possibilidade de que a espessura do aparelho tenha causado o deslocamento para baixo da língua durante máxima intercuspidação habitual, desta forma, aumentando a força lateral nos dentes inferiores.

Neste estudo, a largura nasal não foi comparada com o grupo C, pois os cefalogramas do “Bolton Standards of Dentofacial Developmental Growth” não apresentavam o contorno das paredes laterais da cavidade nasal, mas o grupo T apresentou aumento significativo na largura da cavidade nasal. Concordando com estes achados, Chung e Font (2004) relataram aumento significativo da largura maxilar e da cavidade nasal, logo após ERM.

Ao analisar a expansão rápida dos arcos dentais maxilares e da cavidade nasal, pela abertura da sutura palatina mediana, um dos mais interessantes achados do estudo de Haas (1961) foi à facilidade e a extensão

na qual esta sutura foi aberta na ausência completa de dor. O aumento na largura final do arco, pela abertura da sutura palatina foi permanente, podendo ser garantida pela rápida deposição de novo osso.

Medidas e observações feitas, por vários métodos de trabalhos em animais e clínicos, indicaram que com a abertura do parafuso, a primeira reação foi a inclinação do processo alveolar, acompanhada pela gradual abertura da sutura palatina mediana. Os processos palatinos da maxila começaram a mover-se para baixo em suas margens livres causando o abaixamento da abobada palatina. Além disso, os achados clínicos mostraram que para abertura de 8mm na sutura palatina, houve o aumento da largura nasal de 4,5mm. (Haas, 1961, 1965)

No presente estudo a largura nasal (LNs) apresentou aumento, estatisticamente significativo, em largura de 2,33mm após a intervenção com expansão maxilar, ou seja, em intervalo de tempo de apenas um ano, houve aumento significativo da cavidade nasal. Nos momentos subsequentes continuou havendo aumento na largura nasal de 1,69mm no período T3 e 1,96mm no período T4, que estavam relacionados com o crescimento e que ocorreram em intervalos de 4 e 7 anos, respectivamente.

Oliveira de Felipe, *et al.* (2008) encontraram modificações na anatomia e fisiologia da cavidade nasal após ERM, porém, estas modificações não estavam relacionadas às mudanças no modo de respirar. Segundo os autores, a respiração bucal é fenômeno extremamente complexo e não deve ser considerado de forma simplista. O aumento, estatisticamente significativo, da área palatal durante a fase ativa de expansão pode ser explicado pela

mudança drástica na arquitetura do palato. A separação na base da maxila resultou na configuração mais paralela dos processos palatinos após tratamento. O volume nasal aumentou significativamente entre T1 e T2, manteve estável em T3, e aumentou significativamente até T4.

Usando tomografia convencional, Palaisa *et al.* (2007) constatou aumento significativo no volume total da cavidade nasal e redução na resistência das vias aéreas após ERM. A área e o volume da cavidade nasal na porção mediana e posterior aumentaram mais que na porção anterior, embora a separação da sutura inter-maxilar, com a ERM, seja menor na porção posterior da maxila.

A ERM não interferiu na largura da orofaringe, no comprimento da língua, no comprimento e posição vertical do osso de hióide, com exceção do comprimento das vias aéreas, de acordo com os estudos de Markoç, *et al.* (2007). A expansão foi particularmente efetiva com aumento no tamanho e na largura da cavidade nasal. A ERM não foi, por si só, útil em indivíduos com hipertrofia de cornetos, pólipos nasais, tecidos adenoidianos hipertrofiados ou desvios de septo.

6 CONCLUSÃO

Após verificar, a longo prazo, os efeitos do tratamento da deficiência maxilar transversa com expansão rápida da maxila e sua influência no crescimento e desenvolvimento da maxila e mandíbula, concluiu-se que:

6.1 ocorreu deslocamento anterior da maxila e da mandíbula, giro da maxila no sentido horário e da mandíbula no sentido anti-horário. Houve aumento real em largura da maxila e nenhum efeito sob a largura transversa da mandíbula. Após recidiva da sobrecorreção dentária à distância inter-molares superiores apresentou valores próximos ao padrão de normalidade. À distância inter-molares inferiores exibiu aumento, característico de verticalização destes dentes. Os incisivos superiores inclinaram para vestibular, enquanto os incisivos inferiores inclinaram para lingual.

6.2 Houve correlação positiva entre as modificações ocorridas com o tratamento e os valores médios do “Bolton Standards of Dentofacial Developmental Growth”. Portanto, a expansão rápida da maxila trouxe resultados benéficos para os pacientes que apresentavam deficiência transversa da maxila, favorecendo o crescimento normal no grupo com tratamento.

6.3 A largura nasal apresentou aumento estatisticamente significativo após intervenção com expansão maxilar. Nos períodos subsequentes, continuou havendo aumento na largura nasal devido ao crescimento, porém em quantidades menos expressivas, ao longo do período estudado.

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