UNIVERSIDADE FEDERAL DE MINAS GERAIS
FACULDADE DE MEDICINA
Programa de Pós-Graduação em Saúde da Criança e do Adolescente

CRESCIMENTO FACIAL VERTICAL APÓS A ADENOTONSILECTOMIA EM RESPIRADORES ORAIS: O QUE ESPERAMOS É O QUE ENCONTRAMOS?

BERNARDO QUIROGA SOUKI

BELO HORIZONTE - MG

2009

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Tese apresentada ao Programa de Pós-Graduação em Saúde da Criança e do Adolescente, da Faculdade de Medicina da UFMG, como requisito parcial à obtenção do grau de Doutor em Ciências da Saúde.

Orientador: Prof. Dr. Jorge Andrade Pinto
Co-orientadora: Profa. Dra. Helena Maria Gonçalves Becker

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DECLARAÇÃO

A Comissão Examinadora abaixo assinada, composta pelos Professores Doutores: Jorge Andrade Pinto, Helena Maria Gonçalves Becker, Paulo Augusto Moreira Camargos, Celso Gonçalves Becker, Luc Louis Maurice Werckx e Dauro Douglas Oliveira, aprovou a defesa de tese intitulada: **"CRESCIMENTO FACIAL VERTICAL APÓS ADENOTONSILECTOMIA EM RESPIRADORES ORAIS: O QUE ESPERAMOS É O QUE ENCONTRAMOS? "**, apresentada pelo doutorando **BERNARDO QUIROGA SOUKI** para obtenção do título de doutor em Ciências da Saúde, pelo Programa de Pós-Graduação em Ciências da Saúde - Área de Concentração em Saúde da Criança e do Adolescente da Faculdade de Medicina da Universidade Federal de Minas Gerais, realizada em 27 de novembro de 2009

Prof. Jorge Andrade
orientador

Profa. Helena Maria Gonçalves Becker
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Prof. Paulo Augusto Moreira Camargos

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ATA DE DEFESA DE TESE DE DOUTORADO de **BERNARDO QUIROGA SOUKI** nº de registro 2006218594. Às treze horas e trinta minutos do **dia vinte e sete do mês de novembro de dois mil e nove**, reuniu-se na Faculdade de Medicina da UFMG a Comissão Examinadora de tese indicada pelo Colegiado do Programa para julgar, em exame final, o trabalho intitulado: **"CRESCIMENTO FACIAL VERTICAL APÓS ADENOTONSILECTOMIA EM RESPIRADORES ORAIS: O QUE ESPERAMOS É O QUE ENCONTRAMOS? "** requisito final para a obtenção do Grau de Doutor em Ciências da Saúde, pelo Programa de Pós-Graduação em Ciências da Saúde - Área de Concentração em Saúde da Criança e do Adolescente. Abrindo a sessão, o Presidente da Comissão, Prof. Jorge Andrade Pinto, após dar a conhecer aos presentes o teor das Normas Regulamentares do Trabalho final passou a palavra ao candidato para apresentação de seu trabalho. Seguiu-se a argüição pelos examinadores com a respectiva defesa do candidato. Logo após, a Comissão se reuniu sem a presença do candidato e do público para julgamento e expedição do resultado definitivo. Foram atribuídas as seguintes indicações:

Prof. Jorge Andrade Pinto/orientador	Instituição: UFMG	Indicação: aprovado
Profa. Helena Maria Gonçalves Becker/coorientadora	Instituição: UFMG	Indicação: APROVADO
Prof. Paulo Augusto Moreira Camargos	Instituição: UFMG	Indicação: aprovado
Prof. Celso Gonçalves Becker	Instituição: UFMG	Indicação: Aprovado
Prof. Luc Louis Maurice Werckx	Instituição: UNIFESP	Indicação: Aprovado
Prof. Dauro Douglas Oliveira	Instituição: PUC/MG	Indicação: APROVADO

Pelas indicações, o candidato foi considerada aprovado.
O resultado final foi comunicado publicamente ao candidato pelo presidente da comissão. Nada mais havendo a tratar o presidente encerrou a reunião e lavrou a presente ATA que será assinada por todos os membros participantes da comissão examinadora. Belo Horizonte, 27 de novembro de 2009.

Prof. Jorge Andrade Pinto/orientador ________________

Profa. Helena Maria Gonçalves Becker/co-orientadora ________________

Prof. Paulo Augusto Moreira Camargos ________________

Prof. Celso Gonçalves Becker ________________

Prof. Luc Louis Maurice Werckx ________________

Prof. Dauro Douglas Oliveira ________________

Prof. Joel Alves Lamounier/Coordenador ________________

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Faculdade de Medicina/UFMG

Obs.: Este documento não terá validade sem a assinatura e carimbo do Coordenador.

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À minha amada esposa Barbra, grande incentivadora deste ideal acadêmico. Sem o seu apoio este projeto não chegaria ao final.

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APRESENTAÇÃO

Este trabalho se refere à tese apresentada ao Programa de Pós-Graduação em Saúde da Criança e do Adolescente da Faculdade de Medicina da Universidade Federal de Minas Gerais (UFMG) e representa requisito parcial para a obtenção do título de doutor.

Os questionamentos que motivaram as investigações apresentadas nesta tese, bem como os dados para a sua elaboração, surgiram no Ambulatório do Respirador Oral do Hospital das Clínicas da UFMG (AROHC-UFMG). Tal projeto teve as suas atividades iniciadas em novembro de 2002, sendo aprovado pelo Comitê de Ética e Pesquisa da UFMG (COEP-UFMG) com o parecer ETIC 291/03 sob o título "Estudo das alterações otorrinolaringológicas, fonoaudiológicas, alergológicas, ortodônticas e posturais do respirador oral".

A proposta primária do AROHC-UFMG é a avaliação interdisciplinar de crianças respiradoras orais. Após a anamnese completa, conduzida por otorrinolaringologistas, as crianças são submetidas a exames clínico e complementar por profissionais das áreas de Otorrinolaringologia, Alergologia, Ortodontia e Fonoaudiologia, visando diagnosticar os fatores etiológicos da disfunção respiratória e dar o encaminhamento e/ou orientações terapêuticas.

Até o dia 20 de agosto de 2009, após quase 7 anos de atividades, o AROHC-UFMG atendeu 639 crianças com idade variando entre 2 anos e 8 meses a 12 anos e 9 meses. A média de idade é de 6 anos e 6 meses. Deste total, 364 (56,96%) eram do sexo masculino e 275 (43,04%) do sexo feminino. A indicação de cirurgia para a desobstrução das vias aéreas superiores foi dada para 286 crianças (44,75%).

De acordo com as opções de formato contempladas pelo regulamento do Programa, essa tese se baseia em três artigos produzidos durante o doutoramento, respectivamente intitulados:

1) “Prevalence of malocclusion among mouth breathing children: do expectations meet reality?”
2) “Changes in vertical dentofacial morphology after adeno-/tonsillectomy during deciduous and mixed dentitions mouth breathing children - one year follow up study”
3) “Vertical facial growth following adeno-/tonsillectomy: changing concepts?”

O primeiro artigo (Capítulo 1.1) foi elaborado a partir dos dados coletados durante os primeiros cinco anos de funcionamento do AROHC-UFMG. Ele traz um levantamento epidemiológico sobre a prevalência de más oclusões em um centro de referência para respiradores orais. A reconhecida associação entre a respiração oral e algumas alterações dentofaciais (má oclusão de classe II, mordida aberta anterior e mordida cruzada posterior), faz com que os clínicos tenham a expectativa de encontrar más oclusões na maioria das crianças respiradoras orais. Da mesma forma, é fácil imaginar que o grau de obstrução das vias aéreas superiores tenha associação com a prevalência das referidas más oclusões. Nos primeiros anos de funcionamento do AROHC-UFMG, os profissionais envolvidos com o atendimento perceberam que a expectativa de encontrar más oclusões nas crianças examinadas não era plenamente contemplada. Surgiu, assim, a necessidade de estudar de maneira academicamente formal este assunto, especialmente em uma grande amostra de respiradores orais. Este primeiro artigo foi publicado na revista *International Journal of Pediatric Otorrinolaryngology*, no volume 73, disponível *online* em 12 de março de 2009. Os seus dados principais foram apresentados, na forma de pôster, no XIX ENT World Congress, recebendo o prêmio de Melhor Trabalho na categoria Otorrinopediatria.

O segundo artigo (Capítulo 2.2) traz respostas à dúvida, quanto a eventuais diferenças no padrão de crescimento facial vertical, se a desobstrução cirúrgica das vias aéreas superiores é efetuada durante a fase de dentadura decídua ou na fase de dentadura mista. Este assunto é original na literatura, sob uma perspectiva longitudinal, e pretende adicionar informações que possam auxiliar na decisão sobre a época ideal para a adenotonsilectomia em crianças respiradoras orais. Este artigo foi aceito para publicação na revista *International*

Journal of Pediatric Otorrinolaryngology, recebendo o número IJPORL-D-09-00411.

No terceiro artigo (Capítulo 3.3) é feita uma reflexão sobre o conceito consensual de que as crianças submetidas à desobstrução cirúrgica das vias aéreas superiores adquirem um crescimento facial vertical mais próximo da normalidade. Este artigo será enviado para a publicação na revista *Angle Orthodontist*, após a publicação do Artigo 2, em função deste último servir de referencial metodológico.

Além dos capítulos referentes aos artigos, esta tese traz um capítulo de Considerações Iniciais onde são introduzidos os temas a serem estudados, além da descrição do Objetivo da tese. No capítulo de Considerações Finais é feita uma breve síntese dos achados e são apresentadas as conclusões. Nos Anexos são trazidas 1) a aprovação desta pesquisa pelo Comitê de Ética em Pesquisa da Universidade Federal de Minas Gerais, 2) a versão em PDF da publicação do Artigo 1 e 3) o comprovante de aceitação do Artigo 2 pela revista *International Journal of Pediatric Otorhinolaryngology.*

As citações apresentadas em cada um dos três artigos encontram-se com numeração "entre colchetes" [ ], na seqüência que aparecem nos texto, conforme normas das revistas para qual eles foram encaminhados. A lista de referências bibliográficas encontra-se ao final de cada artigo.

As citações apresentadas nos Capítulos 1 e 3 foram numeradas em ordem alfabética, a partir da lista de referências bibliográficas apresentadas ao final do Capítulo 1.

RESUMO

Introdução: A associação entre a respiração oral e o crescimento dentofacial tem sido descrita na literatura há pelo menos 150 anos. Apesar de uma série de conceitos a respeito deste tema estar consolidado na mente dos clínicos, é lícito questionar se a expectativa criada pelos dados apresentados previamente corresponde à realidade. O que esperamos é o que encontramos? Assim, esta tese teve como objetivo 1) levantar a prevalência de más oclusões associadas com a respiração oral e estudar a sua associação com os fatores obstrutivos nasais, 2) estudar o impacto da adenotonsilectomia (A+A), realizada em dois estágios do desenvolvimento oclusal, no crescimento facial vertical e 3) avaliar se a A+A realmente favorece a melhora do padrão de crescimento facial vertical, utilizando um desenho metodológico diferente, com outro tipo de grupo controle.

Métodos: Tese apresentada no formato de três artigos, com cada um deles respondendo a cada objetivo, respectivamente. O primeiro deles apresenta um levantamento epidemiológico sobre a prevalência de más oclusões (classe II, mordida aberta anterior e mordida cruzada posterior) em uma amostra de 401 crianças respiradoras orais. Por meio de análise univariada foi estudada a associação entre a obstrução das vias aéreas superiores e essas más oclusões. O segundo artigo traz um estudo sobre o crescimento facial vertical, após 1 ano da A+A, em dois estágios do desenvolvimento da oclusão (dentaduras decídua e mista). No terceiro artigo é feita uma avaliação do crescimento facial vertical após a A+A em 39 crianças respiradoras orais (TG). O grupo controle (CG), composto por crianças respiradoras orais com indicação de A+A, foi pareado com o TG em relação à faixa etária, estágio de desenvolvimento da oclusão, gênero e padrão facial vertical.

Resultados: ***Artigo 1* -** A idade média da amostra era de 6 anos e 6 meses (D.P.: 2 anos e 7 meses), com variação entre 2 e 12 anos. Todos os pacientes foram avaliados por otorrinolaringologistas para a confirmação do hábito de respiração oral. Obstrução por adenóide e/ou amígdala foi detectada em 71,8% da amostra, independentemente da presença de rinite. Rinite alérgica, isoladamente, foi encontrada em 18,7% das crianças. Respiração oral não obstrutiva foi diagnosticada em 9,5% da amostra. Mordida cruzada posterior foi encontrada em aproximadamente 30% das crianças durante as fases de

dentaduras decídua e mista e 48% dos indivíduos durante a dentadura permanente. Nas dentaduras mista e permanente a mordida aberta anterior e a má oclusão de classe II foram muito prevalentes. Mais do que 50% das crianças respiradoras orais apresentavam uma relação inter-arcos dentários normal nos três planos do espaço. A análise univariada não mostrou associação estatisticamente significativa entre o tipo de obstrução (hiperplasia por adenóide/amígdala ou presença de rinite) e más oclusões (classe II, mordida aberta anterior e mordida cruzada posterior). ***Artigo 2 -*** Após 1 ano de acompanhamento, nenhuma diferença estatisticamente significativa no crescimento facial vertical foi observada nos grupos submetidos a A+A na dentaduras decídua ou mista, comparativamente aos seus grupos controle obstruídos. Exceção feita à divergência maxilo-mandibular durante a fase de dentadura decídua. ***Artigo 3*** - Crescimento facial significativo ($p<0,000$) foi encontrado para todas as medidas lineares em TG e CG. Uma redução da proporção do terço inferior da face em relação à altura facial total, da inclinação do plano mandibular em relação à base craniana e da divergência maxilo-mandibular, bem como um aumento da proporção da altura facial posterior em relação à altura facial anterior total, aconteceu em TG e CG. Não houve diferença estatisticamente significativa entre a rotação mandibular do TG e CG.

Conclusões:

. A prevalência de mordida cruzada posterior foi maior na população de respiradores orais do que na população geral, independentemente dos estágios de desenvolvimento da oclusão.

. A prevalência de mordida aberta anterior e de má oclusão de classe II foi maior nas crianças mais velhas (dentaduras mista e permanente) do que nas mais novas (dentadura decídua).

. Não houve associação entre a causa da respiração oral (hiperplasia de adenóide, hiperplasia de amígdala, rinite, funcional) e a presença de má oclusão de classe II, mordida aberta anterior e mordida cruzada posterior.

. A maioria das crianças respiradoras orais apresentou uma relação oclusal inter-arcos normal.

. Não houve diferença no padrão de crescimento facial vertical quando a A+A foi realizada nas fases de dentaduras decídua ou mista inicial, exceção feita à divergência maxilo-mandibular durante a dentadura decídua.

. As crianças submetidas a A+A tiveram um crescimento facial predominantemente horizontal, similar à normalidade descrita na literatura.

. As crianças que permaneceram obstruídas por 1 ano também tiveram um crescimento facial predominantemente horizontal.

. Sugere-se a necessidade de uma revisão das conclusões apresentadas previamente por outros autores a respeito do impacto da desobstrução cirúrgica das vias aéreas superiores sobre o padrão de crescimento facial vertical.

SUMMARY

Introduction: The association between nasal impairment and dentofacial morphology has been studied for more than a century. Controversies still exist about this subject, despite a lot of information is available on the literature. Therefore, the purpose of this PhD thesis was to evaluate if expectations meet reality regarding some assumptions previously established on clinicians' minds. Three points were investigated: 1) epidemiological report on the prevalence of malocclusion among a group of children consecutively admitted at a referral mouth breathing (ENT) center, studying the association of such malocclusions and upper airway obstructive factors, 2) the impact of respiration normalization on vertical dentofacial growth during two stages of dental development after adeno-/tonsillectomy (T&A) and 3) the impact of respiration normalization on vertical dentofacial growth after adeno-/tonsillectomy (T&A), controlling the results with a matched group of untreated mouth breathing children.

Methods: The work described in this thesis consists of three papers. Each one answering each objective listed above. The first paper reports a cross-sectional, descriptive study, carried out at an Outpatient Clinic for Mouth-Breathers. Dental inter-arch relationships and nasal obstructive variables of 401 children were diagnosed and the appropriate cross tabulations were done. In the second paper, linear and angular cephalometric measurements, as well as superimposing tracings of serial lateral cephalograms of 39 patients in the treatment group were compared with those of 31 untreated mouth breathing controls. Cephalometric records in the treatment group comprised registrations made at baseline before surgery (T^0), and then at approximately 1 year post-operatively (T^1). Corresponding registrations were available for the control group, with baseline cephalometric radiographs taken approximately 1 year before the second one (T^0 and T^1, respectively). Treated and untreated individuals were divided into deciduous and mixed dentition groups to aid identification of an optimum timing for normalizing the respiration after T&A, under a vertical dentofacial perspective. In the third paper the impact of T&A on the vertical dentofacial growth is revisited after an untreated group of mouth breathing children served as controls.

Results: ***Paper #1* -** Mean age was 6 years and 6 months (SD: 2y7m), ranging

from 2 to 12 years. All subjects were evaluated by otorhinolaryngologists to confirm mouth breathing habit. Adenoid/tonsil obstruction was detected in 71.8% of this sample, regardless of the presence of rhinitis. Allergic rhinitis alone was found in 18.7% of the children. Non obstructive mouth breathing was diagnosed in 9.5% of this sample. Posterior crossbite was detected in almost 30% of the children during primary and mixed dentitions and 48% in permanent dentition. During mixed and permanent dentitions, anterior open bite and class II malocclusion were highly prevalent. More than 50% of the mouth breathing children carried a normal inter-arch relationship in the sagital, transversal and vertical planes. Univariate analysis showed no significant association between the type of the obstruction (adenoids/tonsils obstructive hyperplasia or the presence of allergic rhinitis) and malocclusions (class II, anterior open bite and posterior crossbite).

Paper #2 - After one year of follow up, no statistically significant difference on vertical dentofacial growth was observed in deciduous or mixed dentitions treatment groups compared to same stage untreated control groups. The reduction of the divergence (NL-MP) between maxilla and mandible was statistically significant greater for adeno-/tonsillectomy group during primary dentition.

Paper #3 - Statistically significant growth ($p<0.000$) was found for all linear measurements (SBL-Go, SBL-Me, NL-Me) in both groups (TG and CG). A reduction in LAFH/TAFH, SBL-MP and NL-MP, as well as an increase in PFH/TAFH, were the growth mean behavior both in TG and CG. There was no statistically significant difference between TG and CG regarding the mandibular rotation.

Conclusions:

. The prevalence of posterior crossbite is higher in mouth-breathing children than in the general population.

. During mixed and permanent dentitions, anterior open bite and class II malocclusion were more likely to be present in mouth breathers.

. Although more children showed these malocclusions, most mouth breathing children evaluated in this study did not match the expected “mouth breathing dental stereotype.

. In this population of mouth breathing children, the obstructive size of adenoids or tonsils and the presence of rhinitis were not risk factors to the development of class II malocclusion, anterior open bite or posterior crossbite.

. Regarding the vertical dentofacial growth pattern, normalization of the mode of respiration after T&A in young children (deciduous dentition) is not more effective than in older children (mixed dentition).

. The normalization of the mode of respiration, after T&A, did not change the pattern of mandibular vertical growth, after one year, when compared to a matched untreated group of mouth breathers.

. Apparently, there is a greater clockwise rotation of the anterior portion of maxilla in adeno-/tonsillectomized children than in obstructed controls during primary dentition.

. The previously posted concept that T&A improve the vertical dentofacial growth must be revisited.

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CAPÍTULO 1

Considerações iniciais

1.1 A associação entre a respiração oral e o crescimento dentofacial.

O equilíbrio das funções vitais exercidas pelo sistema estomatognático, dentre elas a respiração nasal, é essencial para que haja o desenvolvimento dentofacial normal, dentro dos padrões morfológico e genético de cada indivíduo [7, 23].

Assim, a função naso-respiratória tem sido de grande interesse nas últimas décadas, devido à sua relação biológica com a forma e a função, e também por causa de sua enorme implicação clínica, para pediatras, otorrinolaringologistas, alergologistas, ortodontistas, fonoaudiólogos, fisioterapeutas e outros profissionais da área de saúde que lidam com pacientes em fase de crescimento [22].

Investigações sobre o impacto de fatores ambientais sobre o crescimento e o desenvolvimento facial têm demonstrado uma associação entre a obstrução das vias aéreas e variadas formas de más oclusões e displasias ósseas [3, 5, 9, 17, 20, 22].

Em humanos, os estudos têm concentrado suas atenções no papel das formas etiológicas mais incidentes de obstrução respiratória causadoras da respiração oral: hiperplasia adenoideana, rinites alérgicas, hiperplasia amigdaliana, hipertrofias de conchas nasais [3, 12, 18].

Por outro lado, trabalhos clássicos com primatas não humanos confirmaram que a obstrução nasal severa à passagem de ar, artificialmente criada, pode causar uma série de más oclusões. Apesar da resposta não ser uniforme entre os animais, a abertura da boca para a realização da respiração oral gradualmente resultou em um plano mandibular mais inclinado e um ângulo goníaco mais aberto [8, 9, 10].

Tomes, em 1872, descreveu o termo “fácies adenoideana”, para indivíduos respiradores orais. Nestes indivíduos, a boca permanece aberta, com falta de selamento labial passivo. O lábio superior é curto, hipofuncionante e o lábio inferior é evertido, hiperfuncionante. A musculatura jugal é relaxada, o nariz é pequeno e pouco desenvolvido. A língua se posiciona inferior e anteriormente, entre os incisivos superiores e inferiores. Os incisivos superiores são projetados para vestibular. O olhar demonstra cansaço e a face apresenta uma expressão atoleimada [26].

Espera-se, ainda, que os respiradores orais crônicos tenham uma atresia maxilar, com tendência a um cruzamento no segmento posterior [3,20], um padrão de crescimento facial vertical excessivo[17], muitas vezes com uma mordida aberta anterior e uma relação oclusal de classe II [22].

Apesar das características dentofaciais descritas acima serem aquelas que vêm à mente da maioria dos profissionais da área de saúde, quando diante de um paciente respirador oral, a literatura mostra que, do ponto de vista epidemiológico, a “fácies adenoideana” típica não é o achado mais comum nos pacientes respiradores orais. Alguns autores, inclusive, questionam a associação entre o padrão respiratório e a morfologia facial [15].

Shapiro[29] concluiu que, apesar do crescente volume de artigos científicos demonstrando as relações entre a obstrução das vias aéreas superiores e o crescimento facial, os clínicos deveriam ter cuidado na indicação de terapias radicais ou na promessa de resultados ousados.

Alterações morfológicas isoladas (como o aumento da altura facial anterior inferior e a atresia dos arcos) são bastante prevalentes em respiradores orais [3, 20], enquanto que a relação sagital inter-arcos mais encontrada é a de classe I e não a de classe II [11, 16].

O crescimento facial verticalmente excessivo (dolicocefalia) é uma preocupação para a Ortodontia, em virtude de suas implicações estéticas e limitações terapêuticas mecânicas[28]. A hereditariedade é o fator etiológico preponderante em relação à dolicocefalia[31], todavia fatores ambientais, como a respiração oral, podem contribuir com o agravamento deste padrão desfavorável de crescimento [3, 5, 17].

Ricketts[26] afirmou que a face dos respiradores orais cresce com excesso vertical devido à rotação mandibular posterior favorecida pela manutenção da boca aberta.

Apesar da controvérsia se a respiração oral é que causaria o excesso de crescimento facial vertical ou se indivíduos com morfologia facial alongada estariam mais susceptíveis à obstrução das vias aéreas superiores[30, 35], é fato que existe uma forte associação entre os respiradores orais e uma face longa [5, 17].

1.2 Normalização da respiração, após a desobstrução cirúrgica das vias aéreas superiores, e o crescimento facial vertical.

Acreditando-se que a respiração oral favorece um crescimento facial excessivo é possível teorizar que a normalização da função respiratória, após a desobstrução cirúrgica das vias aéreas superiores, é capaz de promover uma reversão, pelo menos parcial, deste padrão perverso de crescimento facial.

Diversas publicações descreveram o impacto positivo da adenoidectomia e do aumento do fluxo de ar pelo nariz no crescimento facial vertical. Entretanto, a maioria delas[14,18,19,21,36] foi produto de um mesmo estudo longitudinal, conduzido na Suécia na década de 1960, onde 38 crianças foram acompanhadas por cinco anos e o crescimento comparado com o de indivíduos sem obstrução respiratória.

Linder-Aronson[18] relatou uma redução da divergência entre a maxila e a mandíbula, decorridos 1 e 5 anos pós-adenoidectomia, enquanto que em publicação subseqüente, o mesmo autor principal com co-participação de outros dois pesquisadores[19] descreveram um crescimento mandibular significativamente mais horizontal nas meninas e apenas uma tendência a este padrão de rotação mandibular nos meninos, após a normalização do padrão respiratório.

Kerr, McWilliam e Linder-Aronson[14] estudaram a mudança de forma e posicionamento espacial da mandíbula após a adenoidectomia, concluindo que decorridos 5 anos da normalização da respiração oral o padrão esquelético das crianças se tornou menos dolicocefálico. Eles concluíram que a mudança do padrão respiratório influenciou a rotação mandibular, bem como a sua morfologia.

Behlfelt[2] estudou o efeito do aumento das amígdalas e da sua remoção cirúrgica no crescimento facial. A amostra era composta por 73 crianças com idade média de 10,1 anos. O pesquisador encontrou que crianças com hiperplasia amigdaliana têm maior prevalência de retro-inclinação de incisivos inferiores, protrusão de incisivos superiores, redução do comprimento da arcada inferior, tendência à mordida aberta anterior, aumento da sobressaliência e tendência ao cruzamento na região posterior. Na análise esquelética, estas crianças mostraram ter maior prevalência de retrognatismo mandibular e de rotação horária da mandíbula, aumento na altura facial anterior inferior e mordida aberta. Após a remoção cirúrgica das amígdalas, houve um reposicionamento dorsal da base da língua, favorecendo uma redução da atresia mandibular e da prevalência de mordida cruzada posterior. Identificou-se, também, um aumento da altura facial posterior inferior.

Woodside, Linder-Aronson e Lundstrom[36] verificaram não haver diferenças na direção do crescimento maxilar no grupo de crianças adenoidectomizadas, em relação às crianças sem problemas respiratórios. O crescimento da sínfise mandibular, expresso no queixo, foi maior no grupo de crianças operadas do que no grupo controle normal.

Arun, Isik e Sayinsu[1] investigaram retrospectivamente 66 teleradiografias em norma lateral da face de crianças com história de adenoidectomia precoce (até 4 anos de idade) ou tardia (após 4 anos de idade). Nenhuma diferença estatisticamente significativa foi encontrada nas variáveis esqueletais estudadas, exceção feita à altura facial anterior. Eles concluíram que esta investigação deveria ser considerada como um estudo piloto, sugerindo o monitoramento longitudinal de crianças que forem precocemente submetidas à adenoidectomia.

Mahoni, Karsten e Linder-Aronson[21] tiveram como objetivo determinar se as alturas dentoalveolar e facial, inicialmente aumentadas nas crianças respiradoras orais, são mantidas após a adenoidectomia. As comparações feitas com um grupo de crianças respiradoras nasais, cinco anos após a cirurgia, mostraram que a redução da altura dentoalveolar dos molares superiores e da altura facial anterior inferior estão associadas à mudança do padrão respiratório de oral para nasal.

Recentemente, Zettergren-Wijk, Forsberg e Linder Aronson[37] publicaram os seus achados em relação ao crescimento facial de 17 crianças submetidas à adenoidectomia para o tratamento de Síndrome da Apnéia Obstrutiva do Sono (SAOS). O padrão morfológico facial vertical das crianças portadoras de SAOS, que antes da adenoidectomia era diferente daquele encontrado nas 17 crianças-controle, sem problemas respiratórios, adquiriu características de semelhança 5 anos após sanado o problema obstrutivo.

Chama a atenção, consideração feita por Linder-Aronson, Woodside e Lündstrom[19] que, sob o ponto de vista puramente científico, seria preferível ter uma amostra controle obstruída, ao invés de composta por crianças sem obstrução naso-respiratória. Entretanto tal desenho metodológico, segundo estes autores, teria limitações éticas.

Exceção feita ao estudo de Arun, Isik e Sayinsu[1], em todos os artigos citados anteriormente, pelas crianças estarem na mesma faixa etária (dentadura mista), nenhuma inferência foi feita a respeito do momento ideal para a adenoidectomia.

1.3 Adeno-/tonsilectomia na desobstrução das vias aéreas superiores: existe uma época ideal?

A tonsilectomia tem sido utilizada como procedimento cirúrgico há muito tempo. Em 50 a.c., Celsus já havia descrito uma técnica para tal operação. Já a adenoidectomia, por outro lado, provavelmente não havia sido executada até o final do século XIX, quando Wilhelm Meyer sugeriu que as vegetações adenoideanas eram responsáveis não somente pelos sintomas nasais, mas também pela perda de audição [6].

As duas cirurgias conjuntamente começaram a ser empregadas de maneira cada vez maior no início do século XX, quando a então popular teoria da infecção focal indicava que vários distúrbios sistêmicos, com destaque para o “reumatismo” eram causados pela doença das amígdalas e adenóide [24].

De forma exagerada, entusiastas inclusive indicavam A+A como tratamento para condições diversas como anorexia, retardo mental, enurese ou simplesmente como medida de promoção de saúde [24].

Talvez o apogeu do entusiasmo com a A+A tenha acontecido, em algumas comunidades, onde cirurgias por atacado nas populações infantis aconteciam nas próprias escolas públicas [6].

Após essa fase de indicações excessivas, iniciou-se a fase de contestação com a quase proibição da realização desta cirurgia. O ceticismo na indicação de A+A em larga escala começou a ser progressivamente maior na década de 1930, recebendo reforço positivo a medida que 1) os estudos epidemiológicos indicavam uma redução natural na incidência de infecções do trato respiratório superior, após os primeiros anos de vida escolar, 2) o reconhecimento, no período que antecedeu o surgimento de uma vacina eficaz contra a poliomielite, que crianças submetidas a A+A tinham maior risco de desenvolver esta doença, 3) surgiram novas drogas antimicrobianas eficazes contra as bactérias envolvidas com as infecções respiratórias e 4) um número considerável de estudos eram publicados confirmando que a A+A era ineficaz[24].

O preconceito em relação a A+A, particularmente no meio pediátrico, surgiu e até mesmo ficou exagerado pelas freqüentes indicações inadequadas[24].

Durante os anos de 1950, um importante programa de saúde norte americano (*United Mine Workers of America Health and Retirement Funds*), na esperança de melhorar a qualidade de atenção e também reduzir custos, instituiu a norma de exigir uma avaliação e consentimento prévio de peritos credenciados, em relação a A+A [24].

Ao final dos anos 1960, uma considerável parcela dos livros-texto de pediatria questionava as indicações de amigdalectomia, enquanto uma revisão cética de um conceituado periódico denominou esta intervenção de “ritual cirúrgico” [24].

Em 1976, uma sugestão foi feita propondo que A+A fosse completamente suspenso, até que sua eficácia pudesse ser estabelecida em ensaios clínicos controlados [24].

Não bastasse este ambiente, que variava entre o ceticismo e condenação, o apoio a A+A continuou a existir em vários segmentos da área médica. Estudos que indicaram a associação entre a obstrução das vias aéreas superiores e as alterações no crescimento dentofacial contribuíram com o incentivo à continuidade desta técnica cirúrgica[18].

Atualmente, vivemos a fase de análise de resultados e indicações mais criteriosas, baseadas em estudos científicos, porém o estigma da cirurgia ainda permanece entre alguns profissionais, especialmente da área de Pediatria.

Sob o olhar da Ortodontia, o adiamento da normalização do padrão respiratório, no caso de crianças respiradoras orais, não parece ser uma conduta desejável, por pelo menos duas razões: 1) a respiração oral pode ser um fator etiológico de más oclusões e a persistência de tal interação fisiopatológica tende a agravar as seqüelas dentofaciais [26,27], 2) a maior parte do crescimento facial acontece nos primeiros anos de vida[4].

Entretanto quem geralmente define a época de uma intervenção cirúrgica para a normalização da respiração oral é o médico pediatra. Como, por questões históricas, alguns destes profissionais tendem a recomendar o adiamento da A+A, tal situação é preocupante, uma vez que, até a presente data, não há um relato de estudo clínico controlado para definir a idade limítrofe para a normalização do padrão respiratório, nos casos de obstrução das vias aéreas superiores, sob uma perspectiva ortodôntica, especialmente em relação ao padrão de crescimento facial vertical.

Ao mesmo tempo, acredita-se, empiricamente, que a opinião destes profissionais é, muitas vezes, discordante dos otorrinolaringologistas apesar de haver estudos que demonstrem o contrário [25].

1.4 Objetivo da tese

Diante dos fatos expostos anteriormente, o objetivo desta tese foi avaliar se as expectativas apresentadas a seguir, relacionadas à associação entre a respiração oral e o complexo dentofacial, correspondem à realidade. Ou seja, o que esperamos é o que encontramos?

Expectativa 1: A maioria das crianças respiradoras orais é portadora de má oclusão de classe II, mordida aberta anterior e mordida cruzada posterior, sendo que a gravidade da obstrução das vias aéreas superiores tem associação com estas más oclusões.

Expectativa 2: A desobstrução cirúrgica das vias aéreas superiores de respiradores orais, durante a fase de dentadura decídua, propicia um crescimento facial vertical mais favorável do que quando realizada durante a fase de dentadura mista.

Expectativa 3: A desobstrução cirúrgica das vias aéreas superiores em respiradores orais propicia um crescimento facial vertical mais favorável do que em crianças obstruídas.

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CAPÍTULO 2

Artigos

Artigo 1

Título: Prevalence of malocclusion among mouth breathing children: do expectations meet reality?

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Artigo 1

Prevalence of malocclusion among mouth breathing children: do expectations meet reality?

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Keywords: Mouth breathing, malocclusion, adenoids, tonsils, rhinitis

Abstract

Objective: The aim of this study was to report epidemiological data on the prevalence of malocclusion among a group of children, consecutively admitted at a referral mouth breathing otorhinolaryngological (ENT) center. We assessed the association between the severity of the obstruction by adenoids/tonsils hyperplasia or the presence of allergic rhinitis and the prevalence of class II malocclusion, anterior open bite and posterior crossbite.
Methods: Cross-sectional, descriptive study, carried out at an Outpatient Clinic for Mouth-Breathers. Dental inter-arch relationship and nasal obstructive variables were diagnosed and the appropriate cross tabulations were done.
Results: Four hundred and one patients were included. Mean age was 6 years and 6 months (SD: 2y7m), ranging from 2 to 12 years. All subjects were evaluated by otorhinolaryngologists to confirm mouth breathing. Adenoid/tonsil obstruction was detected in 71.8% of this sample, regardless of the presence of rhinitis. Allergic rhinitis alone was found in 18.7% of the children. Non obstructive mouth breathing was diagnosed in 9.5% of this sample. Posterior crossbite was detected in almost 30% of the children during primary and mixed dentitions and 48% in permanent dentition. During mixed and permanent dentitions, anterior open bite and class II malocclusion were highly prevalent. More than 50% of the mouth breathing children carried a normal inter-arch relationship in the sagital, transversal and vertical planes. Univariate analysis showed no significant association between the type of the obstruction

(adenoids/tonsils obstructive hyperplasia or the presence of allergic rhinitis) and malocclusions (class II, anterior open bite and posterior crossbite).

Conclusions: The prevalence of posterior crossbite is higher in mouth-breathing children than in the general population. During mixed and permanent dentitions, anterior open bite and class II malocclusion were more likely to be present in mouth breathers. Although more children showed these malocclusions, most mouth breathing children evaluated in this study did not match the expected “mouth breathing dental stereotype”. In this population of mouth breathing children, the obstructive size of adenoids or tonsils and the presence of rhinitis were not risk factors to the development of class II malocclusion, anterior open bite or posterior crossbite.

1 Introduction

The association between nasal respiratory impairment and dento-facial morphology has been studied for more than a century [1-3] and for decades it has been strongly accepted that inter-arch growth pattern can be influenced by an unbalanced muscular function on mouth breathers [4].

The knowledge that obstruction of nasal breathing most likely will perversely impact the facial growth even led some authors to propose classic terms to describe such patients as “adenoid faces” [5] , “long face syndrome” [6] and “respiratory obstruction syndrome” [7].

A stereotype of these patients, therefore, can be drawn, where an anterior open bite [8], a reduced transversal dimension [9,10], associated or not with posterior crossbite [11], and a class II malocclusion [12, 13,14] are expected.

However, as individual facial genotypes have different sensitivity on developing malocclusion, following the exposure to mouth breathing, a wide variety of inter-arch relationships can be found.

The emphasis on this mouth breathing stereotype has been unfortunate because it implies that all patients with those clinical findings are mouth breathers and that nasal impaired respiration will ultimately result in this malocclusion. Besides that, one question arises: can we predict the outcome of these malocclusions based on the presence and on the type of airway obstructive cause which led to this deleterious habit?

Routinely, Ear, Nose and throat (ENT) specialists and general clinicians use the diagnosis of the airflow blockage by adenoids and tonsils hyperplasia as a parameter to the establishment of the treatment planning [15]. Although this axiom has been used routinely by clinicians, it has not been sufficiently tested regarding the development of malocclusion.

The aim of this study was to report epidemiological data on the prevalence of malocclusion among a group of children, consecutively admitted at a referral mouth breathing ENT center. We assessed the association between severity of the obstruction by adenoids/tonsillar hyperplasia or the presence of allergic rhinitis and the prevalence of class II malocclusion, anterior open bite and posterior crossbite.

2 Patients and methods

2.1 Population

Four hundred and forty four children consecutively referred by pediatricians and primary care physicians to the Outpatient Clinic for Mouth-Breathers, at the Hospital das Clínicas at Federal University of Minas Gerais (UFMG), Brazil, between November of 2002 and November of 2007, with the chief complaint of mouth breathing were systematically evaluated by a multidisciplinary team comprised by ENT doctors, allergologists and orthodontists, in a single day visit.

Children whose mouth breathing could not be confirmed, those who have had previous orthodontic treatment or were younger than 2 years of age were excluded from the analysis. Therefore, the sample of this cross-sectional study totaled 401 patients.

All subjects were evaluated by otorhinolaryngologists to confirm mouth breathing resulting from at least one of the following airway pathologies: obstructive tonsillar hyperplasia, obstructive adenoidal hyperplasia and allergic rhinitis. The children whose obstruction by one of these conditions could not be diagnosed were classified as functional mouth breathers [16].

The participant's rights were protected, and informed consent and assent were obtained according to the Ethics Committee of the Federal University of Minas Gerais.

2.2 ENT data collection

An interview with children's parents, or guardians, asking about the quality of the children's sleep, snoring, oral breathing and throat infections, confirmed the "chief complaint" of mouth breathing. Parents were also asked if the child had been undergone an adenoidectomy or tonsillectomy earlier. Clinical ENT examination was performed by two of the authors (L.F. and H.B.), according to the following guidelines:

Palatine tonsil hypertrophy was classified by mouth examination according to the criteria of Brodsky and Koch [17] as follows: grade 0 – tonsils limited to the tonsillar fossa; grade 1 – tonsils occupying up to 25% of the space between the anterior pillars in the oropharynx; grade 2 – tonsils occupying 25-50% of the space between the anterior pillars; grade 3 – tonsils occupying 50-75% of the space between the anterior pillars; and grade 4 – tonsils occupying 75-100% of the space between the anterior pillars.

Tonsils grade 0, 1 and 2 were considered as non-obstructive and those classified as grade 3 and 4 were named as obstructive. [18]

Adenoids were assessed by flexible nasoendoscopy and were grouped into two categories based on nasopharyngeal obstruction (<75% and ≥75%). A cut-point of 75% was chosen to classify the blockage of the nasopharynx as obstructive or non-obstructive. [19]

2.3 Allergological data collection

The allergological assessment, to diagnose allergic rhinitis, included a structured medical interview, physical examination, following the standard volar forearm skin prick method, as described elsewhere[20]. These exams were performed in 326 children under the supervision of one of the authors (J.P).

2.4 Dental data collection

The dental clinical examination was performed by a team of orthodontists, who worked together for at least ten years, and were previously calibrated. The subjects were grouped by stage of dental development, according to the variation in primary and permanent teeth eruption, into deciduous, mixed and permanent periods.

The inter-arch occlusion dental classification was based on Barnett [21]:

Vertical: relationship was classified as 1) normal, 2) anterior open bite or 3) deep bite. An open bite was registered in cases that lacked any overbite, regardless of the amount. A deep bite was registered when more than half of the lower incisors were overlapped by the incisal edges of the upper incisors.

Transversal: relationship was classified as 1) normal, 2) posterior crossbite, without mandibular functional shift, and 3) posterior bite, with mandibular functional shift.

Sagital: relationship was classified as a) normal occlusion, b) class I malocclusion, c) class II malocclusion and c) class III malocclusion. During the deciduous and mixed dentitions, it was considered a class I dental relationship when the upper deciduous cuspid intercuspation was set between the lower deciduous cuspid and first deciduous molar. When in permanent dentition the Angle classification was followed.

2.5 Dental data comparison

A large number of studies on the prevalence of malocclusion in different populations have been published. These data served as a reference of what should be the distribution on inter-arch anomalies among a general population, where mouth and nasal breathers were sampled together [28-32, 35-41].

2.6 Statistics

Epi-data was used to enter data. SPSS version 12.0 was used for the analysis. Descriptive statistics and univariate analysis in cross tables are showed. The significance level of $p<0.05$ was chosen. Normality of age distribution was tested using Kolmogorov-Smirnov test.

For each dental and ENT variable, the number of children with the diagnosed status (n) and its prevalence (%) are given.

For the purpose of statistical analysis, dental variables were binarily grouped according to the expected inter-arch relationships in mouth breathing subjects. Therefore the dependent variables examined were class II malocclusion, anterior open bite and posterior crossbite.

The independent ENT variables were the obstructive grade of tonsil and adenoids and the presence of rhinitis.

3 Results

The mean age of this sample was 6 years and 6 months and the standard deviation was 2 years and 7 months. The age of the children ranged between 2 and 12 years. With the exception of 38 children (9.5%), whose mouth breathing was due to functional habit, 363 subjects had an objective airway obstructive factor. Of these children, 288 (71.8%) were judged to have tonsil and/or adenoid obstruction, combined or not with rhinitis. Allergic rhinitis, as the only obstructive cause, was found in 75 children (18.7%).

Table 1 shows the prevalence of the studied variables, by gender. As there was no gender statistically difference ($p > 0.05$), the analysis was done considering boys and girls as a single group.

Table 1 – Prevalence of dental and ENT findings according to gender distribution. Number of children (n) and prevalence given in percentage (n/N x 100%).

Variables	Boys		Girls		Total	
	n	**%**	**n**	**%**	**n**	**%**
Stage of development N=401						
Deciduous dentition	106	26.4	60	15.0	166	41.4
Mixed dentition	110	27.4	99	24.7	209	52.1
Permanent dentition	12	3.0	14	3.5	26	6.5
χ^2 = 6.050 (2 df) p value = 0.05						
Sagital relationship N=384						
Normal occlusion	26	6.8	17	4.4	43	11.2
Class I malocclusion	97	25.3	83	21.6	180	46.9
Class II malocclusion	64	16.7	51	13.3	115	29.9
Class III malocclusion	30	7.8	16	4.2	46	12.0
χ^2 = 2.230 (3 df) p value = 0.526						
Vertical relationship N=385						
Normal	115	29.9	98	25.5	213	55.3
Deep bite	38	9.9	21	5.5	59	15.3
Open bite	67	17.4	46	11.9	113	29.4
χ^2 = 2.349 (2 df) p value = 0.309						
Transversal relationship N=392						
Normal	158	40.3	116	29.6	274	69.9
Posterior crossbite w/o shift	31	7.9	22	5.6	53	13.5
Posterior crossbite w shift	32	8.2	33	8.4	65	16.6
χ^2 = 1.631 (2 df) p value = 0.443						
Tonsils status N=399						
Grades 0, I, II	141	35.3	95	23.8	236	59.1
Grades III, IV	86	21.6	77	19.3	163	40.9
χ^2 = 1.918 (1 df) p value = 0.166						
Adenoid obstruction status N=390						
<75%	95	24.4	70	17.9	165	42.3
≥ 75%	124	31.8	101	25.9	225	57.7
χ^2 = 0.235 (1 df) p value = 0.628						
Rhinitis N=326						
Yes	133	40.8	102	31.3	235	72.1
No	51	15.6	40	12.3	91	27.9
χ^2 = 0.008 (1 df) p value = 0.928						

As seen in Table 1, the majority of the children was within the deciduous (41.4%) or mixed (52.1%) dentitions. In this growth period of their lives, they were susceptible to the unbalanced muscular adaptation to mouth breathing. Only few children (6.5%) were in permanent dentition.

Based on Table 1, 58.1% of the sample had a normal sagital relationship (class I dental relationship). Class I malocclusion was found in 46.9% of these children, the other 11.2% represents the normal occlusion children. Regarding the three stages of occlusal development (Table 2), Class I dental relationship was found in 64.2% during deciduous dentition, 53.8% and 54.2% during mixed and permanent dentitions, respectively.

About 42% of this sample presented with a sagital disharmony, represented by class II or III (Table 1). The prevalence of class III gets higher as kids get older (Table 2).

Considering the 384 children whose sagital classification was done, dental Class II was the sagital relationship of 27% during primary dentition, 32.8% on mixed dentition and 25% on permanent dentition (Table 2).

The vertical inter-arch relationship must be studied in the dental stage of development because of its known physiologic difference along the growing period. Nevertheless, Table 2 brings the information that a normal vertical relationship was found in, at least, 52.7% of the sample, regardless of the dental stage of development. Open bite prevalence was around 30% during the deciduous and mixed dentitions and 20% in permanent dentition.

In the transversal analysis, posterior crossbite was detected in close to 30% of the kids during deciduous and mixed dentitions and 48% in permanent dentition (Table 2).

All comparisons in Table 2 demonstrate that there is no difference in the malocclusion occurrence when comparing the three stages of dental development (p values >0.05).

Table 2- Prevalence of dental and ENT findings in the deciduous. mixed and permanent dentitions. Number of children (n) and prevalence given in percentage (n/N x 100%).

Variable	Deciduous		Mixed		Permanent	
Dental	n	%	n	%	n	%
Sagital relationship N=384	159		201		24	
Normal occlusion	24	15.1	19	9.5	1	4.2
Class I malocclusion	78	49.1	89	44.3	12	50.0
Class II malocclusion	43	27.0	66	32.8	6	25.0
Class III malocclusion	14	8.8	27	13.4	5	20.8
χ^2 p value = 0.196						
Vertical relationship N=385	165		195		25	
Normal	87	52.7	111	56.9	15	60.0
Deep bite	27	16.4	27	13.8	5	20.0
Open bite	51	30.9	57	29.2	5	20.0
χ^2 p value = 0.731						
Transversal relationship N=392	164		203		25	
Normal	118	72.0	143	70.4	13	52.0
Posterior crossbite w/o shift	19	11.6	29	14.3	5	20.0
Posterior crossbite w shift	27	16.5	31	15.3	7	28.0
χ^2 p value = 0.314						
ENT						
Tonsils status N=399	165		208		26	
Grades 0, I, II	83	50.3	133	63.9	20	76.9
Grades III, IV	82	49.7	75	36.1	6	23.1
χ^2 p value = 0.005						
Adenoid obstruction status N=390	161		205		24	
< 75%	43	26.7	102	49.8	20	83.3
≥ 75%	118	73.3	103	50.2	4	16.7
χ^2 p value = 0.000						
Rhinitis N=326	137		168		21	
Yes	79	57.7	136	81	20	95.2
No	58	42.3	32	19	1	4.8
χ^2 p value = 0.000						

Note: χ^2 based on n x 3 tables. n = variable

Regarding the tonsils (Table 1), the more obstructing grades (3 and 4) were found in about 40.9% of the kids, but considering the stratified groups by age (Table 2), kids during early stages (deciduous dentition) had a higher prevalence (49.7%) than latter stages (36.1% and 23.1% during mixed and permanent dentitions, respectively). Table 2 also illustrates that the distribution of tonsillar obstruction shifted according to aging. Children during the deciduous dentition stage of development have more obstructive tonsils than older ones ($p<0.05$).

The adenoid's obstruction of the nasopharynx showed similar epidemiological behavior. Although the average prevalence of the obstructive group (≥75% occupation of nasopharynx space) was 57.7%, (Table 1), when analyzing this variable under the perspective of dental stage of development, it is clear that prevalence declines steeply from 73.3% to 16.7% along the aging (Table 2), with statistically significant difference ($p<0,05$).

The overall prevalence of allergic rhinitis was 72.1% (n=235/326), as demonstrated on Table 1. During mixed and permanent dentitions the proportion of subjects with rhinitis was bigger (81% and 95.2%, respectively) than in deciduous dentition 57.7% (Table 2), a statistically significant difference ($p<0.05$).

Table 3 shows the univariate analysis between grouped malocclusion (dependent variable) and the ENT independent variables. No association was found between the expected type of malocclusion for mouth breathers and the presence of variables that obstruct the nasal airflow ($p>0.05$).

The comparison between our findings and the literature inter-arch prevalence data is done in the discussion section.

Table 3 – Univariate analysis between grouped malocclusion (dependent variable) and the obstructive causes for mouth breathing (independent variables).

Variables	Tonsil/adenoid obstruction	Rhinitis only	No obstructive cause diagnosed	*p value*
Class II malocclusion				
Yes	78	24	13	0.589
No	196	49	24	
Anterior open bite				
Yes	79	24	10	0.710
No	198	48	26	
Posterior crossbite				
Yes	85	26	7	0.242
No	197	48	29	

4 Discussion

Several reports have associated mouth breathing with dental malocclusion. The first papers were limited to clinical impressions of dentistry pioneers who related the disturbance on facial and occlusal harmony to the impairment of nasal breathing in their patients. Later, many papers published reports based on the findings of scientific data collection, mostly considering the skeletal outcome evaluated by cephalometry. However, data on occlusal clinical parameters of mouth breathing children are scarce.

Dental inter-arch relationship, in the three planes of space, is the basic clinical parameter in understanding the patient's occlusion and its behavior when exposed to unbalanced muscular activity. Therefore, it is important to assess the occurrence of occlusal disorders among mouth breathing children.

Despite the large sample size of this study, the limitations of a cross-sectional design needs to be considered. As our sample is comprised only of mouth breathers, the prevalence of dental inter-arch status had to be compared with other epidemiological reports on a general population [28-32, 35-41]. This methodology brings at least two biases**:** 1) it is fact that in a general population a significant number of children are mouth breathers [22-24]. Thus, the difference between the prevalence of malocclusion in this mouth breathing population and a “normal breathing” population would be greater. 2) The reported prevalence varies considerably between the different studies, even among the same population. This divergence in prevalence figures may depend not only on differences for specific ethnic groups [25], but also on wide ranges in number and age among the examined subjects. However, differences in registration methods, i.e. the criteria for the recorded items, are probably the most important factor explaining these differences. Despite these methodological limitations, this study brings results that deserve further discussion.

Our study compared the prevalence of only one malocclusion in each plane of space: class II (sagital), anterior open bite (vertical) and posterior crossbite (transversal), since an occlusal pattern for mouth breathers is well described.

Anomaly studies usually report findings by chronological age. Malocclusion, however, is a manifestation that is related to development of the dentition. Given the great individual variations in dental maturation, it seems logical to determine the prevalence of malocclusion for groups at different stages of dental development, rather than for different age groups. It is interesting to point out that the pattern of distribution of the prevalence of malocclusions does not show any statistical difference among the three stages of dental development (Table 2), as it occurs in the general population [26]. It is expected that the prevalence of each malocclusion changes among the growth period. This fact suggests that in a mouth breathing population, the increase in the prevalence of some malocclusions alter the common pattern.

Regarding the sagital relationship, it is known that race impacts significantly the prevalence of classes I, II and III malocclusions [27]. Therefore, a good comparison is made only with Brazilian data. This was possible in the first two stages of dental development. During primary dentition, the prevalence of class II in our mouth breathing group was 27%. The prevalence found in previous publications in Brazil varies between 6.8% and 30% [28-30]. Our findings are quite similar to a large sample study (n=2139) conducted by Tomita et al. [28].

However our prevalence is higher than found in other studies [29, 30]. Kataoka et al. [29] concluded that the prevalence of class II in their sample was low (6.8%) because their population was comprised only by Japanese-Brazilian ethnic children. This fact, explains the difference between our findings. However, the difference in relation to the results found by Sadakyio et al. [30] (15.6%) can be justified by data collection methodology discrepancies or differences due to mouth breathing.

In mixed dentition, our study's class II prevalence (32.8%) is much higher than the 12.5% reported by Zanetti [31]. This significant discrepancy suggests that in older children, the perverse impact of mouth breathing, on sagital inter-arch development, is greater than on the deciduous dentition. Cheng et al. [11] noted that the younger a subject is, at the time of evaluation, the less the “adenoid” type of facial characteristics is expressed. This opinion corroborates our findings. We can hypothesize that the longer the exposure to the unbalanced muscular function, due to mouth breathing, the greater the risk of developing class II malocclusion. More epidemiological reports on sagital relationship during the mixed dentition stage would be helpful in testing this hypothesis, but only one was found. Longitudinal cohort studies are necessary to test if this hypothesis is correct.

During permanent dentition, the prevalence of class II in this sample was 25%. A comparison with Brazilian data was not possible because no epidemiological study involving general population at this stage was found, regarding this type of malocclusion. Comparing to Horowitz [32], who evaluated American subjects, the prevalence numbers (22.5%) are quite similar to our results. This observation corroborates the conclusions of Howard [33], Leech [34] and McNamara [3]. Nevertheless, comparing our permanent dentition class II findings with the classic study of Emrich, Brodie, Blayney [35], also in the United States, who found 14%, our prevalence was higher. As the size of permanent dentition sample, in our study, was small (n=24), we suggest that other studies, with larger samples, should test this association.

Regarding the vertical inter-arch relationship, the same type of association described to class II was found. Compared to the literature data, the prevalence of open bite during deciduous dentition, in the investigated mouth breathers, was quite similar. While our children's anterior open bite prevalence during deciduous dentition was 30.9%, the revised literature on general population varied between 20.6% and 46.3% [28, 44-46]. But, when analyzing the older children (mixed dentition), an important difference was noted. The prevalence of open bite reported in the reference articles [31, 36-39] varies between 12.00% and 20.1%, while our sample had a prevalence of 29.2%.

In the transverse dimension we found the most significant discrepancy in the prevalence of malocclusion. Dental literature data shows that the prevalence of posterior crossbite ranges from 8% to 22% (40). Prevalence studies on posterior crossbite during permanent dentition are rare, but Thilander et al. [41] found a prevalence of 3.9% during this stage. Therefore we considered 22% as the top value. We found a prevalence of 30.1% of posterior crossbite in whole group. This prevalence of close to 30% in the primary and mixed dentitions and almost 50% in the permanent one is higher than in the general population and deserves additional consideration.

As the etiology of malocclusion has singular characteristics when considering the three different planes of space, this heterogeneity can help with the comprehension of our findings.

Sagital dental inter-arch relationship is mostly determined by heredity [27] and therefore mouth breathing is only a secondary etiological factor to class II development. Most likely, the power of the unbalanced muscular activities, due to mouth breathing, is not enough to shift a solid class I or III patterns into a class II. Maybe those children with a tendency toward a class II, who could growth into class I, depending on environmental factors, are the population candidates who develop class II, when exposed to mouth breathing. Therefore, in an epidemiological analysis, as we did, the prevalence of class II is higher than in the general population, especially in older children.

Vertical dental relationship also has heredity as the major determinant, but environmental factors such as non-nutritious sucking habits and mouth breathing work as secondary causes of anterior open bite [42]. During deciduous dentition, when sucking habits are highly prevalent in Brazil [43], the prevalence of anterior open bite found in our sample of nasal impaired children was within the range cited in previous Brazilian studies [40-42]. However, during mixed and permanent dentitions, as these sucking habits decline in the general population, the difference with our data gets bigger.

The transversal dental relationship, although governed by individual facial genotype [47], suffers greatly from environmental perverse factors [40]. Mocellin et al. [48], found 63.3% of palatal constriction in mouth breathers and 5% in nasal breathers. This fact explains why the discrepancy in the prevalence of posterior crossbite was so significant between the mouth breathers and the general population. As ethnic difference does not influence posterior crossbite [25], the comparison with data from other studies is feasible.

The triad of class II malocclusion, anterior open bite and posterior crossbite, despite showing a higher prevalence in a mouth breather sample than in the general population, is not the most prevalent inter-arch relationship among the studied nasal impaired children. In fact, a significant number of children showed a normal occlusion, even growing with this perverse habit.

It is clear that mouth breathing is capable of adding an environmental weight to the etiology of such malocclusions. However, since heredity plays a more important rule on facial growth and development, we should not expect to find, on an individual basis, many of these dental anomalies. It is not possible, therefore, to predict with any certainty whether or not a mouth breathing child will develop malocclusion, despite the fact that on an epidemiological level, mouth breathers have a higher risk of developing class II, anterior open bite and posterior crossbite than a general population, as shown in other studies [10].

The results of this study suggest that older mouth breathing children (mixed and permanent dentitions) have a tendency toward increasing the prevalence of class II malocclusion and open bite. If this assumption is true, normalizing nasal airflow passage in younger children, instead of postponing ENT treatments, would be beneficial from an orthodontic point of view. This hypothesis needs to be tested in a longitudinal design study.

Our data did not show any association between the prevalence of malocclusion and an obstructive pattern of the tonsils and/or adenoid, nor with the presence of allergic rhinitis. This is a controversial field in which previous studies have shown discordant findings [2, 7, 49-54].

An explanation of this finding is based on morphogenetic sensitivity in the development of malocclusion. If the child facial type is prone to the development of one or more of the studied inter-arch abnormalities**,** mouth breathing will only add an additional etiological “push”, regardless of the severity or the type of the obstruction. Similarly, when a child has a low susceptibility to the development of malocclusion, even in the presence of a greater airflow obstruction, no dentofacial sequela will occur.

If this explanation represents the truth, the risk of developing malocclusion may be proportional to its morphogenetic susceptibility, but not with the severity of the obstruction. In this research, no evaluation of the skeletal pattern was done, which would allow the identification and stratification of the susceptibility. Therefore, it is only possible to speculate that a full spectrum of malocclusion was present. This balanced distribution contributed to the interesting results of no association between malocclusion and the grade of airflow blockage.

Secondly, another point which must be considered is the time lapse between the initiation of mouth breathing and the malocclusion outcome. If we theorize that, over time, children with greater obstruction could develop more malocclusion than children with less severity, using a young sample may explain the lack of association between the tested variables.

One more explanation to our results could be the chosen cut point which classified the tonsils and adenoids hyperplasia as being obstructive or not. As no validation of these clinical criteria was done yet, anyone can argue that a bias on the obstruction classification interfered with the results.

As it was expected, the younger children had more tonsils and adenoids obstruction than older ones [55]. The prevalence of rhinitis, however, was much higher in older children. The reason is linked to Waldeyer's ring involution with aging, consequently reducing the number of older subjects with adenoid or tonsil hyperplasia referred to the hospital. Thus the respiratory ENT complaint of older children tends to be rhinitis.

The findings of this study suggest that, based on the orthodontic point of view, ENT doctors should consider treating all mouth breathing children, regardless of the etiological factor, since it is not possible to identify the risk of developing malocclusion based solely on routinely used criteria.

Further research, with a longitudinal design and using methods that can help in the identification of morphogenetic sensitivity such as lateral cephalometric radiograph, and better evaluation of the severity of airway obstruction could add important information to this topic.

In conclusion, our study showed that the investigated nasal impaired children had a higher prevalence of posterior crossbite than general population at the same stage of development. During mixed and permanent dentitions, anterior open bite and class II malocclusion were more likely to be present in mouth breathers. However, the majority of the children did not match the expected "mouth breathing dental stereotype". We have also showed that, in this sample of mouth breathers, adenoids/tonsils hyperplasia or the presence of rhinitis, have no association with the prevalence of class II malocclusion, anterior open bite and posterior crossbite.

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Artigo 2

Título: Changes in vertical dentofacial morphology after adeno-/tonsillectomy during deciduous and mixed dentitions mouth breathing children - one year follow up study.

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Changes in vertical dentofacial morphology after adeno-/tonsillectomy during deciduous and mixed dentitions mouth breathing children - one year follow up study.

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Keywords: Mouth breathing, adenoidectomy, tonsillectomy, dentofacial growth

Abstract

Objective: The aim of this one year follow up study was to investigate, in mouth breathing children, the impact of respiration normalization on vertical dentofacial growth during two stages of dental development after adeno-/tonsillectomy.

Method: Linear and angular cephalometric measurements, as well as tracing superimposition of serial lateral cephalograms of 39 patients in the treatment group were compared with those of 31 untreated mouth breathing controls. Cephalometric records in the treatment group comprised registrations made at baseline before surgery (T^0), and then at approximately 1 year postoperatively (T^1). Corresponding registrations were available for the control group, with a baseline cephalometric radiograph taken approximately 1 year before the second one (T^0 and T^1, respectively). Treatment and untreated groups were divided into deciduous and mixed dentition groups to aid the identification of an optimum timing for normalizing the respiration after T&A, under a vertical dentofacial perspective.

Results: After one year of follow up, no statistically significant difference on vertical dentofacial growth was observed in deciduous or mixed dentitions treatment groups compared to the same occlusal developmental stage of untreated control groups.

Conclusion: The results indicate that regarding the vertical dentofacial growth pattern normalization of the mode of respiration after T&A in young children (deciduous dentition) is not more effective than in older children (mixed dentition).

1. Introduction

The hyperplasia of adenoids, whether or not combined with tonsil's hyperplasia, may affect the children in many ways, resulting in Eustachian tube dysfunction/otitis media [1,2], rhinosinusitis [1,2], obstructive sleep apnea [3], failure to thrive [4], swallowing problems [1,2], reduced ability to smell and taste [1,2], halitosis [1,2], speech problems [1,2] and abnormal dentofacial growth [5-8]. Some of these consequences are due to the blockage of nasal airflow when oversized tonsils/adenoids lead to mouth breathing.

Mouth breathing is a leading reason for otorhinolaryngological (ENT) consultation [9]. Consequently, tonsillectomy and/or adenoidectomy (T&A) are among the most common surgical procedures in children [10].

In the early years of the 20th century, surgical removal of tonsils was the rule [11] and was overused in many times [2,12]. Therefore, in the last decades there was a tendency towards a more conservative management of the upper airway obstructive tissues [12, 13]. Such an approach has a strong philosophical appeal, but sometimes favors postponing the normalization of respiration. Choosing between a conservative approach or a more aggressive therapy in young children should be based on scientific evidence, rather than on emotion [1].

Among the dentofacial growth abnormalities associated with nasal airflow obstruction, excessive vertical growth has a special concern for orthodontists [14]. The association between mouth breathing and a long facial form can be attributed to the posterior rotation of the mandible that occurs in mouth breathers [15]. Knowing that the vertical growth of the face is closely related to mandibular growth rotation [16], it seems logical that the acquisition of a normal breathing in growing individuals should be a priority.

Previous longitudinal studies have showed that surgical treatment of nasal obstruction in growing individuals results in a vertical facial development closer to a normal pattern [17-23], but have not tested differences on timing of adeno-/tonsillectomy.

Therefore, the aim of this study was to evaluate one year prospectively the cephalometric vertical dentofacial changes of mouth breathing children who had early and late normalization of the mode of respiration, after ENT surgical procedures.

2. Patients and Methods

2.1. Sample

The sample consisted of 70 children, ranging from 3 to 10 years of age referred by pediatricians and primary care physicians to the Outpatient Clinic for Mouth-Breathers, at the Hospital das Clínicas of the Federal University of Minas Gerais (UFMG), Brazil, with a diagnosis of mouth breathing. An interview with children's parents, or guardians, asking about the quality of the children's sleep, snoring, oral breathing and throat infections, confirmed the ''chief complaint'' of mouth breathing. None of the children had been undergone an adenoidectomy or tonsillectomy earlier. Clinical ENT examination was performed by two of the authors (L.F. and H.B.), according to the following guidelines.

Palatine tonsil hypertrophy was classified by mouth examination according to the criteria of Brodsky and Koch [24] as follows: grade 0, tonsils limited to the tonsillar fossa; grade 1, tonsils occupying up to 25% of the space between the anterior pillars in the oropharynx; grade 2, tonsils occupying 25–50% of the space between the anterior pillars; grade 3, tonsils occupying 50–75% of the space between the anterior pillars; and grade 4, tonsils occupying 75–100% of the space between the anterior pillars. Tonsils grade 0, 1 and 2 were considered as non-obstructive and those classified as grade 3 and 4 were named as obstructive [25].

Adenoids were assessed by flexible nasoendoscopy and were grouped into two categories based on nasopharyngeal obstruction (<75% and ≥75%). A cut-point of 75% was chosen to classify the blockage of the nasopharynx as non-obstructive or obstructive [26]. All subjects presented obstructive tonsils and/or adenoids, and were to undergo T&A.

At the beginning of this study, 26 children were within deciduous dentition (19 male and 7 female) and 44 presented in mixed dentition (27 male and 17 female). Angle class I malocclusion was the sagital classification of 25 children (35.7%). Class II was found in 27 subjects (38.6%) and normal occlusion was detected in 18 children (25.7%). Anterior open bite was diagnosed of 22 subjects (31.4%), while a normal vertical inter-arch relationship was present in 29 cases (41.4%). Posterior crossbite was accessed in 14.3% of the children.

The treatment group (TG) was comprised of those 39 children whose surgical procedure was immediately authorized by municipality public healthy service. Obstructive adenoids were detected in 35 children and obstructive tonsils in 23 children of this group. The control group (CG) consisted of 31 patients who had to wait more than one year for the surgical authorization. From this total, 26 had obstructive adenoids and 12 presented obstructive tonsils. The control samples matched the treatment samples as to the mean age at baseline, gender distribution, Angle inter-arch relationship and mean duration of observational periods.

The children were further separated into younger subjects (deciduous dentition at the beginning of the study) and older subjects (mixed dentition at the beginning of the study). Using this stratification, we evaluated age-related differences and trends in four groups: treatment group within deciduous dentition (TG1), treatment group within mixed dentition (TG2), control group within deciduous dentition (CG1) and control group within mixed dentition (CG2).

Among the treatment group children, one had been a thumb sucker. In this patient however, the habit had ceased before the start of the study. Fifteen children in this group had been dummy suckers, but the sucking habit had ceased at least two years before they entered the investigation. Among the controls, none were finger sucker when entering the study and 10 had ceased dummy sucking for over a 1 year period.

Surgical effects on mouth breathing habits were determined with the same ENT criteria used pre-surgically. These findings were confirmed by parents report during bimonthly visits along with the 1 year post-surgical consultations. All control group patients kept their mouth breathing habit during the 1 year period, as reported by their parents quarterly.

The participant's rights were protected, and informed consent and assent was obtained according to the Ethics Committee of the Federal University of Minas Gerais.

2.2. Cephalometric analysis

Standard lateral cephalometric radiographs were obtained to evaluate the skeletal characteristics of the two groups. All radiographs were taken using the same equipment. Cephalometric records in the treatment group comprised registrations made at baseline before surgery (T^0), and then at approximately 1 year post-operatively (T^1). Corresponding registrations were available for the control group, with a baseline cephalometric radiograph taken at baseline and another approximately 1 year after (T^0 and T^1, respectively).

Cephalometric analysis was performed by the same orthodontist (B.S), in random order. Measurements (SNGoGn, NSGn and ArGoGn) routinely used for orthodontic treatment planning were performed to characterize the baseline vertical facial type of subjects [27, 28]. All measurements showed higher angles than on average for the general population. Therefore, the baseline sample was characterized as excessive vertical growing faces.

The assessment of treatment results was based on a previously described reference system traced through craniofacial stable structures [34]. First, the stable basicranial line (SBL) was traced through the most superior point of the anterior wall of sella turcica at the junction with tuberculum sellae (point T) drawn tangent to lamina cribrosa of the ethmoid bone. The next step was the identification of the following five skeletal landmarks [35]: Menton (Me), Gonion (Go), Articulare (Ar), Anterior Nasal Spine (ANS), Posterior Nasal Spine (PNS).

Then, the following angular (.), linear (-) and ratio (/) measurements were obtained and are described below (Fig 1):

1) SBL.MP: determined by the intersection between the SBL and the mandibular plane (Go-Me). This angle measures the inclination of the mandibular plane.

2) NL.MP: determined by the intersection between the nasal line (ANS-PNS) and the mandibular plane. This angle measures the divergence between the maxilla and the mandible.

3) SBL-Me: linear measurement determined by the orthogonal union of the mental point and the SBL, corresponding to the total anterior facial height (TAFH).

4) NL-Me: linear measurement determined by the union of the mental point and the nasal line, measured over the SBL-Me line, corresponding to lower anterior face height (LAFH).

5) SBL-Go: linear measurement determined by the orthogonal union of the gonial point and the SBL, corresponding to the posterior facial height (PFH).

6) Lower/Total anterior facial height ratio (LAFH/TAFH): determined by the ratio between NL-Me and SBL-Me.

7) Posterior/Total anterior facial height ratio (PFH/TAFH): determined by the ratio between SBL-Go and SBL-Me.

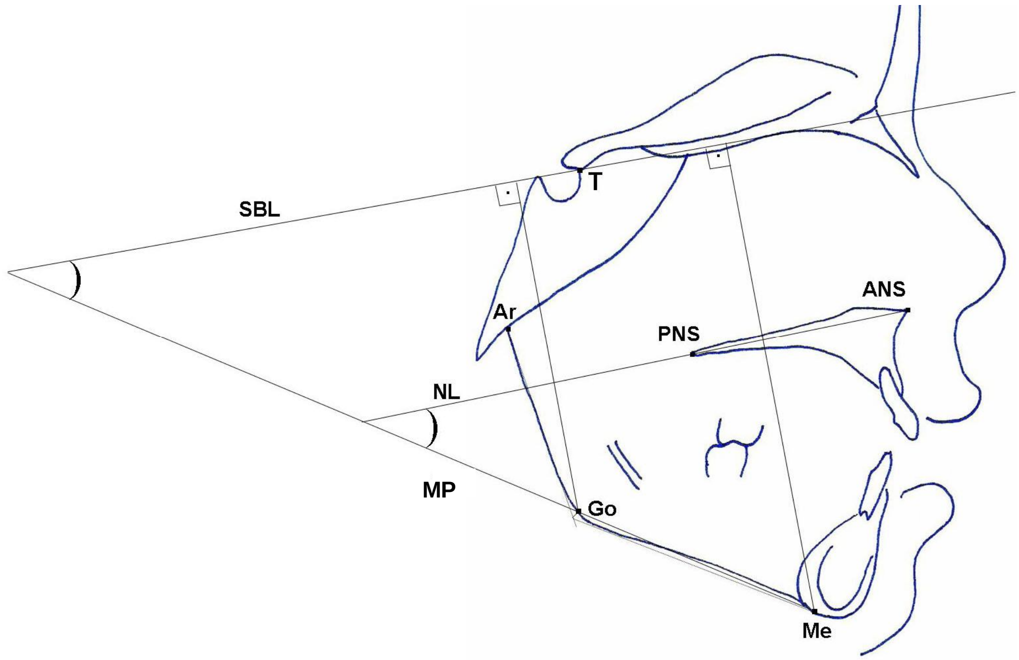

Figure 1 - Cephalogram illustrating the skeletal landmarks, the angular and linear measurements.

Individuals with a vertical growing facial type have an opened mandibular plane angle (SBL.MP), as well as a hyperdivergence of nasal line and mandibular plane (NL.MP). Due to the backward rotation of the mandible, such individuals present a small ratio between the posterior face height and the total anterior face height (PFH/TAFH). A large ratio between the lower anterior face height and the total anterior face height (LAFH/TAFH) is also expected.

Superimposing tracings of serial lateral cephalograms allowed the classification of the mandibular rotation as true rotation, apparent rotation and angular remodeling [30, 36].

True rotation was defined as the angular change between the SBL, at the first and at the second observation, on the superimposed tracings, using fiduciary mandible landmarks (Fig. 2) [34].

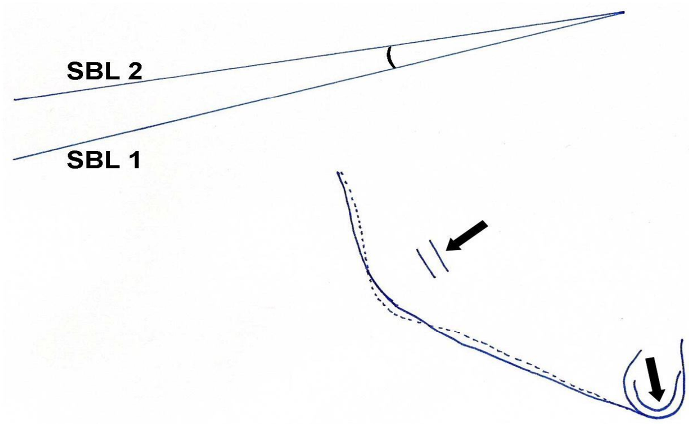

Figure 2 - Mandibular true rotation evaluated by angular changes between T^0 (SBL 1) and T^1 (SBL 2) after the superimposition on the fiducial skeletal landmarks indicated by arrows.

The T^1-T^0 difference between SBL.MP measurements was used to describe apparent rotation. Mandibular apparent rotation can be visualized by superimposing tracings on SBL at point T (Fig. 3). Angular remodeling was defined as the difference between apparent rotation and true rotation.

The cephalometric data were concentrated in tables and subject to statistical analysis for the determination of morphologic differences.

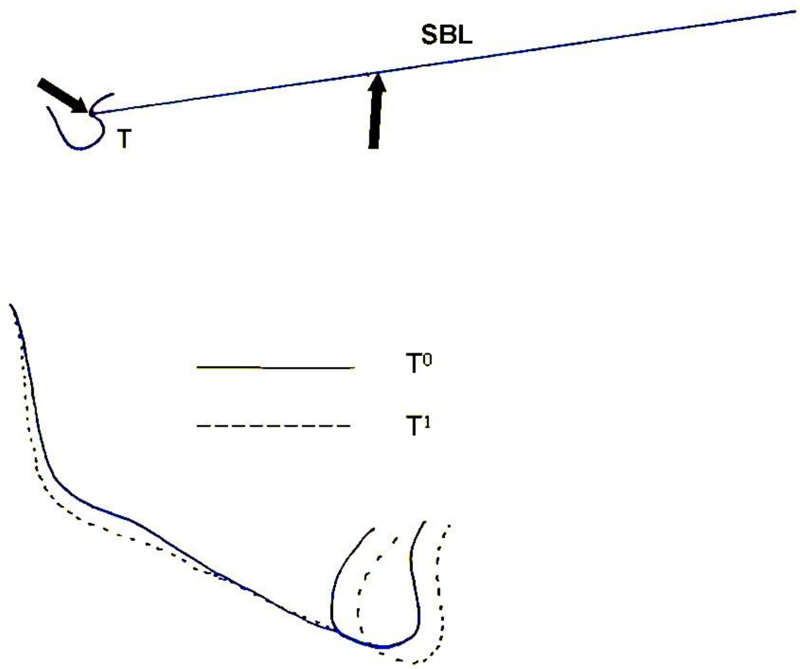

Figure 3 - Mandibular apparent rotation between T^0 and T^1. Superimposition on the SBL at “point T”.

2.3. Error analysis

To determine errors in landmark identification and measurements, 25 cases randomly selected head films were retraced and remeasured by the same orthodontist, after an interval of at least two months. To test inter-examiners reliability, 15 cases were retraced by a second orthodontist (G.P.). Random error was calculated using Dahlberg's equation [37]. Systematic error (bias) was assessed using the paired t-test, for $p<0.05$.

2.4. Data Analysis

The results of Kolmogorov-Smirnov and Levene tests demonstrated the accomplishment of the suppositions of normality and homoscedasticity which allowed the comparison between the means of the two groups and the growth changes with parametric test (independent samples t-test and paired sample t-test respectively). Exception to “angular remodeling”, because the normal distribution and equal variance assumption were rejected, a non-parametric test (Mann-Whitney U test) was used.

To assess significant differences between craniofacial starting forms at the time of the first observation, we compared treatment and control groups at T^0 (TG1 vs. CG1; TG2 vs. CG2).

To overcome discrepancies between treatment and control groups with regard to observation period, all differences were annualized. Craniofacial growth changes (T^1-T^0) in the early-treatment group (TG1) were contrasted with those in the early-control group (CG1). Similarly, the changes in the late-treatment group (TG2) were compared with those in late-untreated group (CG2).

All computations were performed with the Statistical Package for the Social Sciences (SPSS), version 12.0.

3. Results

The systematic error in measurement did not exceed 0.74° or 0.5 mm and thus considered to be of no further importance. The random error ranged between 0.3 and 0.5 mm for the linear measurements and between 0.02° and 0.88° for the angular measurements. There were no statistically significant differences between the two measurements.

The age distribution of the subjects in the experimental and control groups did not showed statistical difference at a probability level of 5% at baseline (T^0). The mean ages in the deciduous dentition (CG1 and TG1) were 5.1 (SD: 0.83) and 4.7 years (SD: 0.93), respectively. During mixed dentition the mean ages were 7.9 (SD: 1.51) during CG2 and 7.5 years (SD: 1.56) during TG2.

Table 1- Independent samples t-test comparison of the baseline (T^0) cephalometric angular and ratio measurements between the treatment (TG) and control (CG) groups during the two stages of dental development (deciduous and mixed dentitions).

	Variable	Groups	*n*	Mean	SD	SE	*p* value
Deciduous dentition	SBL.PM	TG1	13	41.54	4.180	1.159	1.000
		CG1	13	41.54	2.809	0.779	
	NL.PM	TG1	13	34.65	3.782	1.049	0.730
		CG1	13	35.15	3.502	0.971	
	PFH/TAFH	TG1	13	62.00	2.844	0.789	0.285
		CG1	13	60.99	1.794	0.497	
	LAFH/TAFH	TG1	13	57.41	1.746	0.484	0.454
		CG1	13	58.04	2.413	0.669	
Mixed dentition	SBL.PM	TG2	26	42.37	5.684	1.160	0.742
		CG2	18	41.81	5.255	1.238	
	NL.PM	TG2	26	34.11	4.021	0.789	0.373
		CG2	18	33.03	3.821	0.900	
	PFH/TAFH	TG2	26	60.43	3.629	0.729	0.848
		CG2	18	60.21	3.834	0.903	
	LAFH/TAFH	TG2	26	56.73	2.536	0.495	0.870
		CG2	18	56.85	2.118	0.499	

The gender distribution within treatment and controls groups in both stages of dental development were statistically the same (X^2 *p* value >0.05).

No significant differences between craniofacial starting forms for any of the angular and ratio cephalometric variables at T^0 were observed (Table 1). The homogeneity between treatment and control groups with regard to mean age, sex distribution, and craniofacial pattern at T^0 permitted comparison of these paired groups with regard to the growth differences between T^1 and T^0 for all the cephalometric variables.

Tables 2 and 3 display the comparison of the annualized vertical growth result (T^1-T^0) in deciduous and mixed dentition groups. The linear measurements (SBL-Go, SBL-Me and NL-Me) had statistically significant changes between T^0 and T^1 in the treatment groups, as well as in control groups, regardless the stage of dental development. The ratio measurements (PFH/TAFH and LAFH/TAFH) did not have statistically significant changes either during deciduous dentition or mixed dentition surgical intervention, as well as in the untreated control groups. The angular measurements (SBL.MP and NL.MP) showed different pattern of growth comparing deciduous and mixed dentition groups. During deciduous dentition (Table 2) the reduction of SBL.MP angle from T^0 to T^1 did not show statistically significant differences either in the treatment and control groups. However, during mixed dentition (Table 3), the SBL.MP reduction was statistically different for the treatment and control groups. The NL.PM changes in the mixed dentition groups were similar. Both treatment and control groups had a reduction of the divergence between maxilla and mandible (p>0.05) (Table 3). Nevertheless, the deciduous dentition treatment group showed a statistically significant reduction of the divergence between maxilla and mandible, whereas the untreated control group had an increase in the divergence (Table 2).

Table 2- Paired-sample t-test comparison between changes of cephalometric measurements in T^0 and T^1 for the group of children submitted to T&A during deciduous dentition (TG1) and its untreated matched control group (CG1).

Groups	Variables	T^0		T^1		T^1 vs. T^0		
		Mean	SD	Mean	SD	Mean difference	SD	*p* value
TG1 (n=13)	SBL.PM	41.54	4.180	41.23	4.461	-0.31	2.146	0.615
	NL.PM	34.65	3.782	33.92	3.499	-0.73	1.091	0.033
	SBL-Go	58.77	3.244	61.65	3.478	2.88	1.861	0.000
	SBL-Me	94.88	5.443	99.34	4.780	4.46	1.919	0.000
	NL-Me	54.42	2.596	56.96	2.193	2.54	1.265	0.000
	PFH/TAFH	62.01	2.844	62.10	2.953	0.09	1.041	0.748
	LAFH/TAFH	57.41	1.746	57.38	1.790	-0.03	0.650	0.896
CG1 (n=13)	SBL.PM	41.54	2.809	41.04	2.940	-0.50	1.732	0.318
	NL.PM	35.15	3.502	35.42	2.978	0.27	1.549	0.543
	SBL-Go	60.07	4.334	63.12	4.496	3.05	1.450	0.000
	SBL-Me	98.50	6.416	102.39	7.056	3.89	1.401	0.000

NL-Me	57.08	2.921	59.19	3.159	2.11	1.157	0.000
PFH/TAFH	60.99	1.794	61.66	1.800	0.67	1.155	0.057
LAFH/TAFH	58.04	2.413	57.91	2.211	-0.13	0.610	0.449

Paired samples correlation were all higher than 0.849 (p value 0.000)

Table 3- Paired-sample t-test comparison between changes of cephalometric measurements in T^0 and T^1 for the group of children submitted to T&A during mixed dentition (TG2) and its untreated matched control group (CG2).

Groups	Variables	T^0		T^1		T^1 vs. T^0		
		Mean	SD	Mean	SD	Mean difference	SD	*p* value
TG2 (n=26)	SBL.PM	42.36	5.687	41.69	5.591	-0.67	1,306	0.026
	NL.PM	34.11	4.023	33.75	4.271	-0.36	1,730	0.288
	SBL-Go	64.17	5.001	66.20	5.780	2,03	1,712	0.000
	SBL-Me	106.25	6.172	109.06	6.451	2,81	1,479	0.000
	NL-Me	60.27	4.341	61.81	4.835	1,54	1,394	0.000
	PFH/TAFH	60.42	3.629	60.86	4.179	0.44	1,537	0.765
	LAFH/TAFH	56.73	2.526	56.65	2.328	-0.08	1,228	0.159
CG2 (n=18)	SBL.PM	41.81	5.255	41.25	5.303	-0.57	1.055	0.039
	NL.PM	33.03	3.821	32.31	2.855	-0.72	1.750	0.098
	SBL-Go	64.00	5.104	66.28	5.319	2.28	1.691	0.000
	SBL-Me	106.31	5.311	109.11	5.579	2.80	1.373	0.000
	NL-Me	60.44	3.988	61.39	4.496	0.95	1.282	0.006
	PFH/TAFH	60.20	3.834	60.75	3.949	0.55	1.297	0.091
	LAFH/TAFH	56.75	2.118	56.64	2.376	-0.11	0.788	0.089

Paired samples correlation were all higher than 0.844 (p value 0.000)

Table 4 gives information on mandibular rotation in the four groups. No statistically significant difference on mandibular rotation was found between treatment and control groups, despite the stage of dental development.

Table 4– Independent samples t-test comparison of mandibular rotation (true rotation. apparent rotation and angular remodeling) between treatment (TG) and control (CG) groups during deciduous and mixed dentitions.

Groups	Variables	TG		CG		TG vs. CG		
		Mean	SD	Mean	SD	Mean difference	SE difference	*p* value
Deciduous dentition	True rotation	-0.70	2.131	-0.84	2.877	0.14	0.993	0.886
	Apparent rotation	-0.51	2.488	-0.62	2.139	0.11	0.910	0.905
	Angular remodeling *	0.19	1.662	0.22	2.106	0.03	0.744	0.964
Mixed dentition	True rotation	-1.52	2.831	-1.06	1.620	0.46	0.718	0.543
	Apparent rotation	-0.69	1.759	-0.58	1.118	0.11	0.430	0.809
	Angular remodeling*	0.82	1.945	0.48	1.348	0.34	0.540	0.525

* Mann Whitney U Test

Figure 4 illustrates the net growth observed between T^0 and T^1 during deciduous and mixed dentitions, comparing the mean values found in treatment and control groups. Negative values indicate that a measurement reduction, while positive values indicate an increase. An independent t-test comparison of the means indicates that the divergence between maxilla and mandible during deciduous dentition is the only variable that had inter-group statistically significant difference.

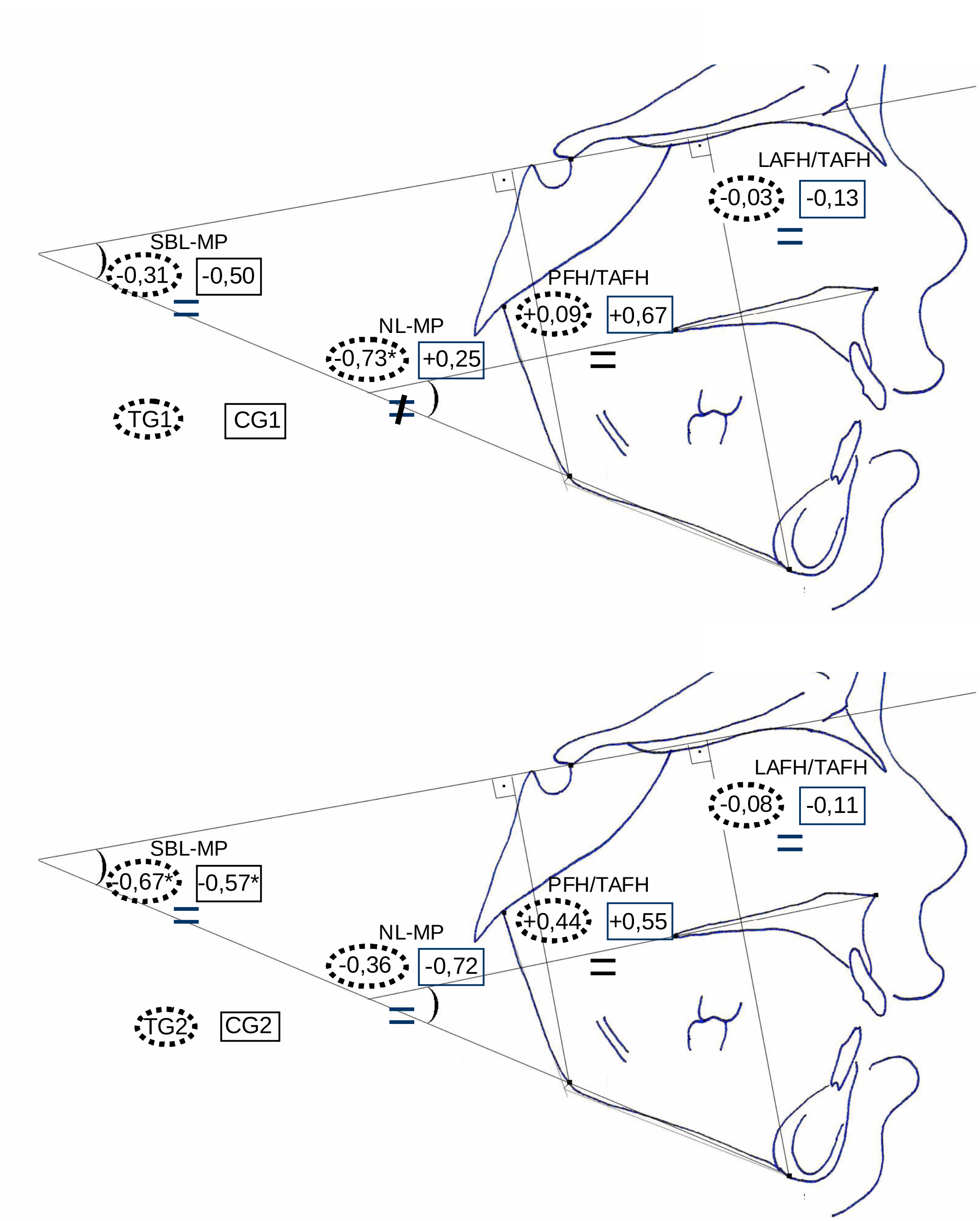

Figure 4 – Net growth measured in the four groups (TG1, CG1, TG2, CG2). Negative values mean measurement reduction between T^0 and T^1 while positive values indicate increase.

* indicates statistically significant intra-group difference
= indicates no statistically significant inter-group difference

4. Discussion

Although absolute and relative evidence-based indications for T&A are well described in the ENT literature, the pendulum of public and professional opinion concerning these surgical procedures continues to swing between enthusiasm and condemnation [2].

Postponing T&A in young mouth breathing children is sometimes the physician's choice due to surgical complications concerns[2], as well as because adenoids and tonsils airflow obstruction gradually undergo a reduction after 5 years of age [26]. However, if the mode of respiration does not shift to nasal, such a conservative approach can contribute to unfavorable excessive vertical dentofacial growth, since clockwise mandible rotation is most likely to occur [15].

Considering that a significant facial growth happens early in life [32], it is possible to theorize that allowing a child to breath with difficulty years ahead, can contribute to a more mature dentofacial abnormality.

Arun, Isik and Sayinsu [33] investigated retrospectively 66 lateral cephalometric radiographs of subjects with early (up to 4 years of age) and late (after 4 years of age) adenoidectomy history. No statistically significant difference was found among the studied skeletal vertical parameters, with exception to the lower anterior facial height. They concluded that their investigation should be considered as a pilot study, suggesting a longitudinal monitoring of children who had early adenoidectomies. This knowledge can contribute to the understanding of the benefits of early breathing normalization, by surgical management of adenoids and tonsils hyperplasia, from the orthodontist's point of view.

Therefore, the primary question of the present investigation was: do children who have an early change in the mode of respiration, after T&A, grow differently than late treatment children?

We established that the children within the deciduous dentition group, at baseline, were in the "early" group, while children in mixed dentition were grouped as “late”. Using the dental stage of development as a cut point has the advantage of been an easy clinical criteria. We conscientiously chose this criteria, even knowing that such a parameter has one disadvantage that can bias our conclusions.

Because dental development is independent of pubertal growth [38], children within the same stage of dental development, even matched in chronological ages, can be in different maturational stages. Therefore, a comparison using skeletal maturational parameters would be more sensitive. However using hand-wrist radiographs would not be practical in a daily clinical perspective, and cervical vertebral maturation method using the lateral cephalogram is not indicated for very young children [42]. Future studies should include maturational stage of development as indication of early and late intervention.

True mandibular rotation provides important information for an understanding of dentofacial growth changes [30, 40]. The literature has shown that the mandible typically rotates in a forward direction [30, 39] with greater rates of true rotation during childhood than during adolescence [30]. This behavior is independent of gender or sagital dental malocclusion classification [30]. As our sample was comprised only by childhood individuals, it was expected that the true mandibular rotation would follow this forward pattern. However, as environmental variables, such as mouth breathing, were present in all children, maybe a backward rotation tendency could happen, lessening or reversing the forward rotation.

The rates of true rotation, apparent rotation and angular remodeling, either during deciduous or mixed dentitions, were not affected by T&A. No statistically significant difference was found between treatment and control groups, as showed in Table 4.

The annual changes (degree/year) in true rotation observed in this study for mixed dentition children were –1.52 and -1.06 for treatment group and control group, respectively. Such rates are similar to those previously reported for general population during the transition from primary to early mixed dentition [30] and for 5- to 10-year-olds [16]. The similarity between our findings and in the general population's suggests that the presence of mouth breathing, or the normalization of respiration after T&A, does not alter the mandible rotation during mixed dentition.

During the deciduous dentition, the annual changes (degree/year) in true rotation was smaller (-0.69 and -0.84 for TG1 and CG1, respectively), but the forward counterclockwise prevailed. It is possible to speculate that the relatively low rates of true rotation in our sample could be due to age differences. However, such finding is contradictory to Wang, Buschang and Behrents [30]. The fact is that both treatment and control groups showed a similar pattern of mandible true rotation, thus T&A seamed to have no influence on such variable after 1 year.

The apparent rotation was very similar in all four groups. We found that a counterclockwise rotation of about 0.5 degrees was the mean annual change. Therefore, the mandible rotated forward regardless the stage of dental development. The rates of apparent rotation are similar to those previously reported [16,30].

As commented by Wang, Buschang and Behrents [30], subjects undergoing greater true mandibular rotation will also undergo greater remodeling. The lower border of the mandible is compensating to maintain its orientation in response to faster rates of true rotation. We had a higher rate of angular remodeling in mixed dentition groups, whose true rotation was also higher.

Our cephalometric analysis showed that mouth breathing children submitted to T&A have the same vertical dentofacial growth behavior as their matched controls, regardless of the stage of dental development, suggesting that normalizing the breathing pattern during late deciduous dentition or during mixed dentition did not make difference. Such results are in agreement with those reported in the transversal study of Arun, Isik and Sayinsu [33], where timing of T&A did not influenced the vertical dentofacial growth.

The only measurement that showed a different pattern of change between T^0 and T^1 was the angular divergence between maxilla and mandible in the group of children adenotonsillectomized during deciduous dentition. This group (TG1) had a significant reduction of the NL.MP angle, while its control group (CG1) had a not significant increase. However, we considered that the vertical improvement of such measurement alone is not sufficient to consider the deciduous dentition as a better moment to T&A.

Analyzing our sample mean age, during deciduous dentition, it is clear that late primary dentition prevails, thus this group is older than the 4 years old suggested by Arun, Isik and Sayinsu [33] as an age limit to consider as early for T&A. This fact may have influenced the results. Maybe if the children in the deciduous dentition were younger other results could be found. Additional research, including younger children, as well as, the identification of other independent variables, can bring supporting data as to the timing of T&A.

Previous longitudinal studies [17-23], which evaluated changes in dentofacial growth of mouth breathers following T&A, used nasal breathing subjects as controls. We opted to use an untreated mouth breathing sample as the control group, understanding that this methodology better represents what should be the expected growth if no intervention was performed, as previously mentioned by Linder-Aronson et al. [19]. Therefore, normative data available in the literature for general population can not be used for comparisons. The data collection for this type of control group, without ethical concerns, was possible because in this population, the time span between the surgery indication and the government authorization to it, in several cases, was long due to high demand. Fortunately, our findings showed that waiting such a long time for the opportunity to be operated on did not worsen the vertical dentofacial pattern of such children. Such information suggests the necessity of additional studies, using untreated mouth breathing children as controls, to investigate the behavior of dentofacial growth after T&A.

The five year follow up, reported in previous studies, would be less sensitive to measurements errors, as commented by Linder-Aronson et al. [19]. However, with our research design, the observational period is limited. As the reported changes in the first year post-operativelly are apparently enough to indicate modifications on the mode of growth [29], we believe that 1 year follow up brings us important data to discuss.

The reported data allow us to believe that postponing mouth breathing treatment from late deciduous dentition to mixed dentition will not, on average, favor an undesirable dentofacial vertical growth. Our study, however, does not indicate in all cases that postponing the normalization of mouth breathing is not harmful to vertical dentofacial growth. Despite not being the subject of our study, we believe that depending on the facial morphogenetic susceptibility, vertical growth behavior of some mouth breathing children may be deleterious and should be avoided. Clinicians must be aware of such cases and establish individually the appropriate timing to surgical intervention.

In conclusion, our results indicate that, regarding the dentofacial vertical growth pattern, normalization of the mode of respiration in young children (deciduous dentition) is not more effective than in older children (mixed dentition).

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Artigo 3

Título: Vertical facial changes following adeno/-tonsillectomy: changing concepts?

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Artigo 3

Vertical facial changes following adeno/-tonsillectomy: changing concepts?

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Keywords: Mouth breathing, adenoidectomy, tonsillectomy, dentofacial growth

Abstract

Objective: The aim of this one year follow up study was to investigate, in mouth breathers, the impact of respiration normalization on vertical dentofacial growth after adeno-/tonsillectomy (T&A) controlling the results with a matched group of untreated mouth breathing children.

Method: Linear and angular cephalometric measurements, as well as superimposing tracings of serial lateral cephalograms of 39 patients in the treatment group (TG) were compared with those of 31 untreated mouth breathing controls (CG). Cephalometric records in the treatment group comprised registrations made at baseline before surgery (T^0), and then at approximately 1 year post-operatively (T^1). Corresponding registrations were available for the control group, with a baseline cephalometric radiograph taken approximately 1 year before the second one (T^0 and T^1, respectively).

Results: Statistically significant growth ($p<0.000$) was found for all linear measurements (SBL-Go, SBL-Me, NL-Me) in both groups (TG and CG). A reduction in LAFH/TAFH, SBL-MP and NL-MP, as well as an increase in PFH/TAFH, were the growth mean behavior both in TG and CG. There was no statistically significant difference between TG and CG regarding the mandibular rotation.

Conclusion: The results indicate that the normalization of the mode of respiration, after T&A, did not change the pattern of mandibular vertical growth, after one year, when compared to a matched untreated group of mouth breathers.

1. Introduction

Previous studies reported that the mandible typically rotates in a forward direction during childhood and adolescence[1]. However Lavergne and Gasson[2] using metal implants demonstrated that only occasionally the mandible exhibit a simple pattern of rotation. In most cases the rotational phenomenon appears to be complex with variations in direction and intensity.

Individuals with backward rotation of the mandible and an increased lower anterior facial height are of concern to Orthodontists due to aesthetics, functional and mechanical reasons[3]. Excessive vertical dentofacial growth is associated with heredity[4], but environmental factors such as mouth breathing can play an important rule in the growth direction[5-9].

The association between mouth breathing and a long facial form can be attributed to the posterior rotation of the mandible that occurs in nasal impaired children[10]. This backward rotation most likely occurs due to a greater vertical growth in the molar region than at the condyles, which happens when the mouth is maintained open.

A series of publications signed by Swedish [5,6,11-13] researchers have set the concept that normalization of mouth breathing after adenoidectomy, leads children to a vertical dentofacial growth closer to a normal pattern. The control groups of those reports were composed by healthy subjects who had no history of nasal obstruction or nasorespiratory allergy.

Despite the conclusion that adenoidectomy has a positive impact on vertical dentofacial growth, Linder-Aronson, Woodside and Lündstrom[6], in the discussion of one of those articles, recognized that it would have been preferable, from a purely scientific point of view, to have unoperated but obstructed control samples. However, this would have been unethical.

Considering that using healthy subjects as controls could bias the previously reported results, a question arises whether the reported data are robust enough to sustain the prevailing concept that normalizing the mode of breathing after surgical otorhinolaryngological (ENT) procedures will improve the dentofacial vertical growth. Therefore, an ethical research design with untreated mouth breathing children, would contribute to the comprehension of this growth behavior.

The high demand for medical assistance in the Brazilian public health service determined a long waiting line, what implies that many severely obstructed children have to wait over a year for the authorization to surgical procedures. Thus, such patients, growing under the influence of mouth breathing can contribute to a better understanding of the natural development of the disease and its consequences.

The purpose of this study was to compare the dentofacial vertical growth and the mandibular rotation of a group of children who underwent adenotonsillectomy to normalize the mode of breathing with an untreated mouth breathing control group.

2. Patients and Methods

2.1. Sample

The sample consisted of 70 children of both sexes, ranging from 3 to 10 years referred by pediatricians and primary care physicians to the Outpatient Clinic for Mouth-Breathers, at the Hospital das Clínicas at Federal University of Minas Gerais (UFMG), Belo Horizonte, Brazil, with a diagnose of mouth breathing. Otorhinolaryngological examination (ENT) confirmed the obstructed nasal airflow. All subjects had enlarged tonsils and/or adenoids, and were to undergo

T&A.

The treatment group (TG) was comprised of those 39 children (14 female and 25 male) whose surgical procedure was immediately authorized by municipality public health service. The control group (CG) consisted of 31 patients (10 female and 21 male) who had to wait more than one year for the surgical authorization. The control group matched the treatment group as to the mean age at baseline, gender distribution, and mean duration of observational periods.

Among the treatment group children, one had been a thumb sucker. In this patient however, the habit had ceased before the start of the study. Fifteen children in this group had been dummy suckers, but the sucking habit had ceased at least 2 years before they entered the investigation. Among the controls, none were finger suckers when entering the study, and 10 ceased dummy sucking for more than 1 year.

The surgery was successful in all treated patients and resolved mouth breathing, a fact which was verified by parents report during bimonthly visits along with 1 year post-operative consultations. All control group patients kept their mouth breathing habit during the 1 year period, as reported by their parents quarterly.

The participant's rights were protected, and informed consent and assent was obtained according to the Ethics Committee of the Federal University of Minas Gerais.

2.2. Cephalometric analysis

Standard lateral cephalometric radiographs were obtained to evaluate the skeletal characteristics of the two groups. All radiographs were taken using the same equipment. Cephalometric records in the treatment group comprised registrations made at baseline before surgery (T^0), and then at approximately 1 year post-operatively (T^1). Corresponding registrations were available for the control group, with a baseline cephalometric radiograph taken at baseline and another approximately 1 year after (T^0 and T^1, respectively).

Cephalometric measurements (SNGoGn, NSGn and ArGoGn) routinely used for orthodontic treatment planning were performed to characterize the baseline vertical facial type of subjects [14, 15]. However, to assess the treatment results, a previously described reference system traced through craniofacial stable structures [16] was choisen. The cephalometric landmarks and measurements used in this study have been published elsewhere [23].

The cephalometric data were concentrated in tables and subject to statistical analysis for the determination of morphologic differences between treatment and control groups.

2.3. Error analysis

To determine errors in landmark identification and measurements, 25 cases randomly selected head films were retraced and remeasured by the same investigator (B.S), after an interval of at least two months. In order to test inter-examiners reliability, 15 cases were retraced by a second orthodontist (G.P.). Random error was calculated using Dahlberg's equation [17]. Systematic error (bias) was assessed using the paired t-test, for $p<0.05$.

2.4. Data Analysis

The results of Kolmogov-Smirnov and Levene tests demonstrated the accomplishment of the suppositions of normality and homoscedasticity which allowed the comparison between the means of the two groups and the growth changes with parametric test (independent samples t-test and paired sample t-test respectively). Exception to “angular remodeling”, because the normal distribution and equal variance assumption were rejected, a non-parametric test (Mann-Whitney U test) was used.

To assess significant differences between craniofacial starting forms at the time of the first observation, we compared treatment and control groups at T^0 (TG vs. CG).

To overcome discrepancies between treated and control groups with regard to observation period, all differences were annualized. Craniofacial significance of the changes (T^1-T^0) in the TG was contrasted with those in the CG using a paired sample t-test.

Mandibular rotation in TG was compared with CG using an independent sample t-test or Mann-Whitney U test. All computations were performed with the Statistical Package for the Social Sciences (SPSS), version 12.0.

3. Results

The systematic error in measurement did not exceed 0.74° or 0.5 mm and thus considered to be of no further importance. The random error ranged between 0.3 and 0.5 mm for the linear measurements and between 0.02° and 0.88° for the angular measurements. There were no statistically significant differences between the two measurements.

The age distribution of the subjects in the treatment and control groups did not showed statistical difference at a probability level of 5% at baseline (T^0). The mean age in the TG was 6.5 (S.D.:1.92) and 6.7 (S.D.:1.85) for CG. The gender distribution within treatment and controls groups were statistically the same (X^2 p value = 0.750).

No significant differences between TG and CG, regarding the craniofacial starting forms, for any of the cephalometric variables at T^0 were observed (Table 1). The homogeneity between treated and control groups with regard to mean age, sex distribution, and craniofacial pattern at T^0 permitted comparison of the groups with regard to the differences between the values at T^1 and at T^0 for all the cephalometric variables.

Table 1- Comparison of the baseline (T^0) cephalometric angular, linear and ratio measurements between the TG (n=39) and CG (n=31).

Variable	Groups	Mean	SD	SE	t-test *p* value
SNGoGn	TG	38.8	4.52	0.73	0.874
	CG	38.7	4.10	0.74	
NSGn	TG	70.4	3.44	0.55	0.946
	CG	70.4	2.98	0.54	
ArGo.GoMe	TG	134.6	4.17	0.67	0.375
	CG	133.7	4.59	0.83	
SBL.PM	TG	42.2	5.26	0.86	0.652
	CG	41.6	4.33	0.77	
NL.PM	TG	34.2	4.00	0.65	0.703
	CG	33.9	3.78	0.67	
SBL-Go	TG	63.2	8.56	1.40	0.598
	CG	62.3	5.11	0.91	
SBL-Me	TG	101.2	10.43	1.71	0.425
	CG	103.0	6.91	1.24	
NL-Me	TG	58.1	4.80	0.78	0.429
	CG	59.0	3.90	0.70	
PFH/TAFH	TG	0.6362	0.1736	0.0285	0.331
	CG	0.6052	0.0312	0.0056	
LAFH/TAFH	TG	0.5784	0.6225	0.0102	0.675
	CG	0.5735	0.0228	0.0041	

Table 2 gives the comparison of the annualized vertical growth result (T^1-T^0) in the treatment and control groups. Statistically significant growth ($p<0.000$) was found for all linear measurements (SBL-Go, SBL-Me, NL-Me) in both groups (TG and CG).

Both TG and CG showed the same pattern of vertical facial growth with a reduction in LAFH/TAFH, SBL-MP and NL-MP, and an increase in PFH/TAFH (Table 2). However analyzing statistically such changes, the reduction of divergence between maxilla and mandible (NL-PM) was significant only for treatment group. For LAFH/TAFH, SBL-MP and PFH/TAFH the statistically significant difference was detected only for the control group.

Table 2- Comparison between the treatment group (TG) and control group (CG) for changes within each pair of variable using a paired Student's t-test.

Groups	Variables	T^0		T^1		T^1 vs. T^0		
		Mean	SD	Mean	SD	Mean diff	SD	*p* value
TG	SBL.PM	42.2	5.26	41.8	5.17	-0.4	1.61	0.124
	NL.PM	34.2	4.00	33.7	4.08	-0.5	1.55	0.041
	SBL-Go	63.2	8.56	65.6	9.07	2.4	1.83	0.000
	SBL-Me	101.2	10.43	104.6	10.07	3.4	1.75	0.000
	NL-Me	58.1	4.80	60.1	4.84	2.0	1.38	0.000
	PFH/TAFH	63.62	17.36	63.83	17.28	0.21	1.38	0.349
	LAFH/TAFH	57.86	6.22	57.84	6.05	-0.02	1.06	0.923
CG	SBL.PM	41.6	4.33	41.1	4.40	-0.5	1.35	0.036
	NL.PM	33.9	3.78	33.6	3.25	-0.3	1.71	0.328
	SBL-Go	62.3	5.11	64.9	5.16	2.6	1.61	0.000
	SBL-Me	103.0	6.91	106.2	6.99	3.2	1.46	0.000
	NL-Me	59.0	3.90	60.4	4.08	1.4	1.34	0.000
	PFH/TAFH	60.52	3.12	61.13	3.21	0.60	1.21	0.009
	LAFH/TAFH	57.35	2.28	56.93	2.37	-0.41	0.74	0.004

Paired samples correlation were all higher than 0.892 (p value 0.000)

The categorized vertical dentofacial changes (T^1-T^0) is brought in Table 3. The comparison between TG and CG resulted in no statistically significant difference for PFH/TAFH, SBL-PM and NL-PM ($p > 0.05$). However, statistically significant more control group children had a reduction in LAFH/TAFH than treated ones.

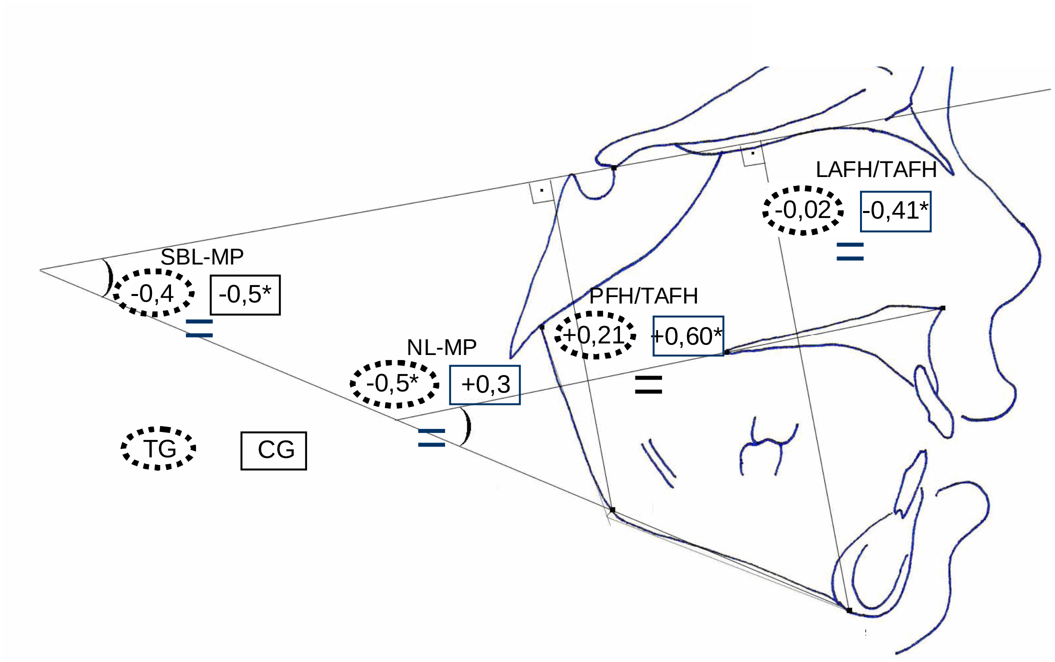

Figure 1 – Net growth measured in the treatment group (TG) and control group (CG). Negative values mean measurement reduction between T^0 and T^1 while positive values indicate increase.

* indicates statistically significant intra-group difference
= indicates no statistically significant inter-group difference

Figure 1 illustrates the net growth observed between T^0 and T^1 comparing the mean values found in treatment and control groups. Negative values indicate that a measurement reduction, while positive values indicate an increase. In all variables, there was a coincidence in the direction of growth. The reduction of SBL.MP and NL.MP angles and LAFH/TAFH ratio, as well as the increase in the PFH/TAFH ratio are indicative of an improvement in the vertical dentofacial growth in both TG and CG. The independent t-test comparison of the means indicates no inter-group statistically significant difference, despite some variables had a statistically significant different intra-group mean difference between T^0 and T^1.

Table 3- Comparison between the treatment group (TG) and control group (CG) for nominal changes in vertical facial proportions (LAFH/TAFH and PFH/TAFH) and skeletal rotation (SBL-PM and NL-PM) using χ^2 test.

Variable	T^1-T^0	Groups		
		TG	CG	*p value*
LAFH/TAFH	Increase	22	6	
	Decrease	17	25	0.002
PFH/TAFH	Increase	23	21	
	Decrease	16	10	0.451
SBL-PM	Increase	19	11	
	Decrease	20	20	0.266
NL-PM	Increase	20	15	
	Decrease	19	16	0.810

Table 4- Comparison between the treatment group (TG) and control group (CG) mandibular rotation using an independent sample t-test.

Variables	Groups	Mean	SD	SE	*p* value
True rotation	TG	-1.24	2.62	0.42	
	CG	-0.97	2.19	0.39	0.643
Apparent rotation	TG	-0.63	2.00	0.32	
	CG	-0.60	1.59	0.28	0.935
Angular remodeling*	TG	0.61	1.85	0.30	
	CG	0.37	1.68	0.30	0.581

* Mann Whitney U test

No statistically significant differences were observed between TG and CG regarding the mandibular rotation (true or apparent), nor the angular remodeling. A forward (counterclockwise) mandible growth direction was the mean behavior of both groups (Table 4).

4. Discussion

As the linear measurements of vertical facial length increased significantly (p value < 0.000) from T^0 to T^1 in both groups (Table 2), the authors suppose that the amount of growth in the investigated children allowed the present study.

The morphological pattern of the investigated subjects at baseline is in agreement with previous published data [14, 15], confirming that mouth breathers present, in average, an excessive vertical growth. It was found an SNGoGn angle close to 39º, an NSGn angle of 70º and an ArGo-GoGn angle around 134º (Table 1). Those numbers are representative of a hyperdivergent patient.

Comparing the present investigation findings with those reported previously [5,6,11-13], based only on the treatment group of children, the results are similar. Mouth breathers who had surgically removed their upper airway obstruction tend to grow horizontally, with a reduction of their facial hyperdivergence. However, due to differences in the control groups our conclusions are different.

In the present invstigation both treated and untreated mouth breathers showed similar vertical facial growth one year prospectively, therefore we can not conclude that surgical upper airway desobstruction changes the vertical pattern of growth.

In our study, the control group was composed of severely obstructed children, with the same respiratory limitations of the treatment group. In the former publications [5,6,11-13] the control group was composed by nasal breathers who had no histories of upper airway obstruction, nasorespiratory allergy, or recurrent otitis media. Those children had never undergone adenoidectomies or orthodontic treatment.

Besides that, the previous researchers used the information that treatment children had significantly greater lower face heights and steeper mandibular planes than the control children[6,13], to propose that mandibular growth direction in the treatment group would keep growing more vertically than an unobstructed control group.

Such a statement was taken from one of these papers [6]: *"From the literature one would expect that a sample of children with severely obstructed* *nasopharyngeal airways would show a more vertical mandibular growth direction than would unobstructed matched controls. Following adenoidectomy and the establishment of nose breathing, growth directions that approach those of the controls might be expected.”*

Considering that mouth breathers will grow always increasing the vertical facial morphology, the methodology employed previously was adequate. But such an assumption presented to us an intriguing question: does mouth breathers` face consistent grow vertically?

The unexpected answer that this group of researchers found was no. In fact, in a one year follow up, our sample of obstructed control group of children had a forward growth of the mandible, a reduction in the inclination of mandibular plane (SBL.MP), a reduction in the divergence of maxilla and mandible (NL.MP), a reduction in the lower anterior face height ratio to total anterior face height (LAFH/TAFH), and an increase in the posterior face height ratio to total anterior face height (PFH/TAFH). All of these characteristics, certified one year prospectively, change the previous assumption that severely obstructed children will grow vertically, and thus hint at the necessity of revising the concept that the improvement in the vertical growth of the face, following T&A, is merely due to the change of the mode of respiration.

The authors of this study recognize that one year follow up may be an insufficient length of time to affirm that obstructed mouth breathers will keep growing within the same pattern. In fact, Lavergne and Gasson [2] have showed that constancy in face growth direction is not the rule. But, if Waldeyer´s ring tissues spontaneously decrease with age [19], we can expect that if we could re-examine those children 5 years later, most of them would have a broader upper airway, therefore growing with less influence of obstructive tissues.

We studied the vertical growth of the dentofacial complex measuring the mandibular rotation, the divergence of mandible to the maxilla and the proportions of the posterior face height and lower anterior face height to anterior total face height. The choice of these measurements is in agreement with current concepts of cephalometry for this type of investigation.

The rates of true mandibular rotation observed in this study (Table 5) were similar to those reported previously by papers on the general population [1,20-22]. We found a true forward rotation of -1.24 degree/year for the treatment group and -0.97 degree/year for the untreated control group. Such rates confirm that both obstructed and adenotonsillectomized children have a pattern of mandible growth within normality. The mandible apparent rotation also had a forward pattern with similar rates (0.6 degree/y) in treatment and control groups, as well as for those previously reported for the general population in the same age group [1]. On the basis of this data, the current sample had a forward mandibular rotation, even in children presenting upper airway obstruction.

The reduction in the mandible to maxilla divergence was the cephalometric parameter used by Linder-Aronson[5] to affirm that following adenoidectomy and a switch from mouth to nose breathing, the mandible anterior rotation in the operated children was greater than in the unobstructed control group. He found, after a five-year observational period, that the reduction of such divergence in the treatment group (4.0°) was statistically significantly greater than in the unobstructed control group (2.3°). However, after the first year of follow up, the difference in the reduction (0.9° and 0.5° for adenoidectomy and the control, respectively), was not statistically significant.

In the present investigation it was found a reduction in the divergence between maxilla and mandible of 0.5° (SD 1.55°) for the treatment group and 0.3° (SD 1.71°) for the untreated control. Such a difference is also not statistically significant when compared the inter-groups net changes (independent t-test *p value*>0.05). However, analyzing the differences within each group, the reduction of NL-MP from 34.2 to 33.7 in the treatment group is statistically significant (paired t-test p value <0.05), while the reduction from 33.9 to 33.6 in the control group is not statistically significant (p value 0.328). Calls attention the high standard deviation, what indicates that the data are spread out over a large range of value, therefore needing to be interpreted with caution.

Thus, regardless if we consider the five-year observational period inter-group difference information provided by Linder-Aronson[5] or the one-year follow up intra-group difference information brought by the present investigation, it seems that there is a significant reduction in the divergence of the maxilla and the mandible following adenoidectomy and a switch from mouth to nose breathing. However, such change must be associated with a clockwise rotation of the nasomaxillary complex, rather than a counterclockwise rotation of the mandible. Such rotation in the adenoidectomy group was illustrated in the superimpositions previously brought by Figures 6 and 7 in the Kerr, McWilliam and Linder-Aronson[13] paper, as well as in the Zettergren-Wijk, Forsberg, Linder-Aronson [12] results.

The connection between normalization of nasal breathing and a greater clockwise rotation of the maxillary anterior portion can be attributed in part to an improvement in the functionality of the nasal cavity and therefore the stimulus that such function exerts over the nasal cavity floor downward growth[24].

Facial height, particularly the LAFH and posterior face height PFH, is well known to be a result of the interplay between condylar growth and sutural and alveolar development [25]. The use of LAFH/TAFH and PFH/TAFH ratios rather than absolute values is more appropriate in determining facial height patterns [26].

We found that the PFH/TAFH ratio increased both in the treatment group as well as in the untreated control, but such changes in the proportion of the face after one-year follow up was significant only for those children who kept mouth breathing. The same fact was observed regarding LAFH/TAFH. Both groups had a decrease in the proportion, but the difference was significant only in the control group (Table 3). In fact, the proportion of the control group children who had a decrease of LAFH/TAFH was larger than the treated subjects (Table 4). Therefore, the control group had a facial growth different from what was supposed previously [6].

Such a finding was unexpected but supports the point of view that using an untreated control group changes the conclusion of previous statements.

As a 5-year follow up with untreated mouth breathing control would be unpractical, from an ethical and physiological perspective, we suggest that an increase in the number of children in the control group could add a more robust confirmation of our findings. Also useful would be a self controlled study design, where the growth of mouth breathers, one year pre-adenotonsillectomy, could be compared with the one year post-surgical changes for each patient.

Conclusions

• In the group of adeno-/tonsillectomized children, the mandible showed a forward rotation, the divergence between maxilla and mandible decreased, the PFH/TAFH ratio increased and the LAFH/TAFH decreased.
• The untreated control group presented the same pattern of hyperdivergence reduction.
• The previous concept that normalization of mouth breathing leads to a better vertical dentofacial growth shoul be revisited.

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CAPÍTULO 3

Considerações finais

A elaboração de uma tese geralmente parte de um planejamento ideal, mas durante a sua execução limitações metodológicas muitas vezes se apresentam aos pesquisadores. Com o intuito de contribuir na execução de pesquisas futuras, o objetivo deste capítulo foi trazer uma reflexão acerca de algumas limitações metodológicas, bem como uma síntese desta tese .

Foram apresentados, por meio de artigos, os resultados de três investigações sobre algumas expectativas que tínhamos a respeito da associação entre a respiração oral e o crescimento dentofacial. Algumas delas surgiram por conceitos já estabelecidos na literatura, outras baseadas em algumas hipóteses plausíveis de serem formuladas sobre este tema.

Optamos pela denominação “expectativa” ao invés de “hipótese” para diferenciarmos do modelo clássico de uma tese onde o teste de hipóteses segue um padrão ortodoxo, diferente do aqui adotado.

A revisão da literatura sinalizou que há consenso no conceito de que a normalização da respiração oral, após a adenoidectomia, favorece um crescimento facial, no aspecto vertical, mais próximo daquele presente em crianças sem obstrução nasal. Entretanto, como nestas publicações não é feita nenhuma menção à época da desobstrução cirúrgica, é razoável criarmos uma expectativa de que quanto mais cedo for normalizada a respiração, melhor será o crescimento facial vertical doravante. Considerando a importância desta informação, para a eleição de um momento mais favorável para uma eventual intervenção cirúrgica otorrinolaringológica, faz-se necessária a avaliação se esta expectativa corresponde à realidade. Exatamente isto é que foi abordado no Artigo 2.

Exceção feita à divergência entre a maxila e a mandíbula, que sofreu maior redução na dentadura decídua, as outras variáveis cefalométricas examinadas não apresentaram diferenças significantes estatisticamente. Portanto, os resultados encontrados neste estudo mostraram que, sob o parâmetro do crescimento facial vertical, não há diferença em operar as crianças durante a fase de dentadura decídua completa ou na fase de dentadura mista final.

Este achado nos faz refletir se nas áreas médica e odontológica, na ânsia de atuar terapeuticamente o mais cedo possível, intervenções desnecessárias (*over-treatment*) podem estar sendo indicadas. Assim, os clínicos devem ter cuidado na indicação de terapias cujos resultados não sejam comprovados.

Em função das crianças respiradoras orais desta amostra, tanto dos grupos tratamento como dos grupos controle, apresentarem ao exame radiográfico inicial um padrão dolicocefálico (excesso de crescimento vertical), imagina-se que em algum momento prévio uma disfunção naso-respiratória possa ter contribuído com tal morfologia facial. Portanto, a época crítica para a desobstrução cirúrgica poderia ser anterior a aquela investigada. Talvez durante a fase de irrupção da dentição decídua. Tal suposição é compatível com a opinião expressa em artigo prévio[1] que avaliou este assunto em um estudo transversal. Entretanto, não é possível descartar a hipótese de que crianças com padrão morfogenético dolicocefálico sejam mais susceptíveis à respiração oral e, portanto, a associação entre a obstrução nasal e o aspecto facial teria uma relação causal inversa, conforme proposto por Warren[35] e, também, Smith e Gonzáles[30]. Isto se confirmando, a época da desobstrução das vias aéreas superiores pouco interferiria com o padrão facial vertical. Estudos complementares são necessários para elucidar tal dúvida.

A consideração feita por Linder-Aronson, Woodside e Lundstrom[19] que, sob o ponto de vista científico, seria melhor que o grupo controle fosse composto por indivíduos doentes, sem tratamento, coloca em questionamento o conceito previamente estabelecido, pelo grupo liderado pelo próprio autor principal, que a adenoidectomia propicia um crescimento facial vertical mais próximo da normalidade.

Um novo desenho metodológico, onde no grupo controle a doença expressaria a sua história natural, elucidaria esta questão. Esta investigação foi apresentada nos Artigos 2 e 3. Tal metodologia somente foi possível, sob o ponto de vista ético, uma vez que a autorização para a cirurgia otorrinolaringológica, de responsabilidade das autoridades públicas de saúde na região metropolitana de Belo Horizonte, rotineiramente leva um prazo aproximado de um ano para ser obtida.

Os resultados mostraram que, no grupo submetido à adenotonsilectomia, o padrão de crescimento facial tendeu a ser horizontal, reduzindo a hiperdivergência facial. Portanto, coincidindo com os achados prévios descritos na literatura[14,18,19,37].

Entretanto, nas crianças respiradoras orais não tratadas do grupo controle, o comportamento do crescimento facial vertical foi semelhante ao grupo tratamento. Desta maneira, as conclusões por nós estabelecidas são antagônicas aquelas apresentadas anteriormente. Os nossos achados sugerem que o crescimento facial vertical, após a adenotonsilectomia, não corresponde à expectativa prévia.

A grande variabilidade do padrão morfológico facial vertical nas crianças analisadas nos Artigos 2 e 3, bem como a falta de um cálculo amostral prévio, contribuíram para que algumas das variáveis estudadas apresentassem um baixo poder ao testes estatísticos ($1-\beta$). Assim, os nossos achados ficaram expostos a erros do Tipo II (β), isto é termos resultados falso-negativo onde a hipótese nula é aceita quando a hipótese alternativa é que é a verdadeira.

Em virtude das limitações temporais impostas pela necessidade de defesa da tese de doutoramento, o tamanho da amostra foi balizado pelos artigos que estudaram este assunto anteriormente[14,18,19,21,36,37]. Como o número de crianças investigadas naqueles artigos foi menor ou igual a 38, estabelecemos tal *n* como uma meta mínima para o nosso estudo. Assim, na presente investigação trabalhou-se com as 39 crianças disponíveis para o grupo tratamento na data limite para o fechamento dos dados que seriam analisados. A nossa meta seria alcançar para o grupo controle, no mínimo, o mesmo número de crianças, mas manter as crianças que não haviam sido operadas, sob um controle longitudinal, não foi tarefa fácil. Fatores como a) perda de contato com a família, b) desistência pela longa espera pela cirurgia, c) ter sido operado ao longo do período observacional, fizeram com que o número de crianças no grupo controle fosse menor do que o idealizado (*n*=31).

Entretanto, em virtude da relevância dos achados aqui apresentados, é essencial a continuidade da coleta de dados no AROHC-UFMG, aumentando o tamanho da amostra o que poderia contribuir com o aumento do poder dos testes estatísticos e, consequentemente, maior robustez às inferências aqui introduzidas.

De qualquer maneira, com a grande variabilidade apresentada nas medidas cefalométricas utilizadas, mesmo com amostras enormes, estaríamos sujeitos a erros do Tipo II. Se esta variabilidade for uma característica do crescimento facial vertical, pouco poderia ser feito. Entretanto, uma opção seria buscar medidas cefalométricas onde o desvio-padrão fosse menor.

Nós optamos pelas medidas cefalométricas aqui apresentadas por aceitarmos as considerações de Tollaro, Baccetti & Franchi[33] que a linha cefalométrica mais estável para estudos com crianças muito jovens é a SBL. Entretanto, avaliações do padrão facial vertical podem ser feitas com inúmeras outras medidas cefalométricas, que talvez apresentem menor variabilidade em torno da média. Isto é, perderíamos em função da menor confiabilidade da referência anatômica, porém ganharíamos em função da maior confiabilidade do poder dos testes estatísticos.

Como exercício para solucionar esta limitação de nosso estudo, procuramos avaliar o poder do teste (1-β) de artigos que estudaram previamente este assunto utilizando, porém, outras medidas cefalométricas[13,14,21,34,37]. De forma unânime, em todas aquelas publicações encontramos também medidas cefalométricas com um baixo poder estatístico.

Todavia, segundo Soares e Siqueira[31], *em estudo onde o tamanho da amostra é fixo*, que é o nosso caso pela imposição temporal da coleta de dados, *não há como controlar simultaneamente ambos os erros (Tipos I e II)*. *Assim,* *convencionou-se que o erro mais sério seria do Tipo I. Em um segundo momento, calcula-se o tamanho da amostra que reduza a probabilidade do erro do Tipo II a níveis aceitáveis*.

Outra consideração importante de ser postada é que a presença de rinite alérgica não foi considerada. Dois motivos nos levaram a esta decisão: a) o tratamento desta patologia é de baixa previsibilidade de resultados, dificultando o controle desta variável e b) os estudos prévios também não consideraram este fator etiológico. Somos da opinião que a solução do problema respiratório após a adeno-/tonsilectomia, com o consistente relato que a criança não mais apresenta roncos noturnos, permanecendo com a boca fechada, é um dado soberano que indica que independentemente da presença de rinite alérgica houve uma mudança do padrão respiratório de bucal para nasal.

As informações previamente apresentadas na literatura sinalizam que as crianças respiradoras orais têm maior prevalência de algumas más oclusões, como a classe II, a mordida aberta anterior e a mordida cruzada posterior. Tal conceito gera uma expectativa que, diante de um respirador oral, as referidas anomalias sejam frequentemente encontradas. Além do mais, imagina-se que quanto maior a obstrução das vias aéreas superiores, maior será a prevalência de tais más oclusões. Assim, no Artigo 1 é apresentado o estudo da associação entre a prevalência destas más oclusões e a respiração oral. Os resultados confirmaram que a prevalência de mordida cruzada posterior é maior nos respiradores orais, do que na população em geral. Da mesma forma, crianças nas fases de dentaduras mista e permanente têm maior prevalência de mordida aberta anterior e classe II. Entretanto, contrariando as nossas expectativas, a severidade da obstrução nasal não mostrou associação com as más oclusões estudadas, além de que a maioria das crianças respiradoras orais não é portadora de anormalidade na relação dentária inter-arcos.

Como os dados para a elaboração do Artigo 1 foram oriundos dos prontuários das crianças do AROHC-UFMG, importantes informações epidemiológicas que poderiam ser levantadas sobre a relação dentária intra-arco e inter-arcos não puderam ser coletadas, uma vez que quando da idealização dos prontuários estes dados não foram considerados relevantes.

Por exemplo, sentimos que a quantificação dos trespasses dentários vertical (*overbite*) e horizontal (*overjet*), bem como a mensuração da proporção entre largura e profundidade maxilar, poderiam contribuir significativamente com o entendimento sobre a relação entre respiração oral e más oclusões.

Ainda no Artigo 1, a ausência de um grupo composto por crianças com padrão respiratório normal que serviria de controle para as comparações epidemiológicas foi outra limitação metodológica. Assim, foi necessário comparar nossas crianças com dados prévios da literatura.

Considerou-se a possibilidade de um levantamento epidemiológico que buscasse conhecer a prevalência das más oclusões estudadas na população geral de Belo Horizonte. Entretanto, respeitamos uma recomendação anterior do COEP-UFMG, onde diagnosticar lesões de cárie e más oclusões e não dar algum encaminhamento para a solução do problema poderia gerar um desconforto emocional aos pacientes e, portanto, seria desaconselhável eticamente.

Conclusões:

. A prevalência de mordida cruzada posterior foi maior na população de respiradores orais do que na população geral, independentemente dos estágios de desenvolvimento da oclusão.

. A prevalência de mordida aberta anterior e de má oclusão de classe II foi maior nas crianças mais velhas (dentaduras mista e permanente) do que nas mais novas (dentadura decídua).

. Não houve associação entre a causa da respiração oral (hiperplasia de adenóide, hiperplasia de amígdala, rinite e respiração oral funcional) e a presença de má oclusão de classe II, mordida aberta anterior e mordida cruzada posterior.

. A maioria das crianças respiradoras orais apresentou uma relação oclusal inter-arcos normal.

. Não houve diferença no padrão de crescimento facial vertical quando a A+A foi realizada na fase de dentadura decídua ou na fase de dentadura mista inicial.

. As crianças submetidas a A+A tiveram um crescimento facial predominantemente horizontal, semelhante ao comportamento dos pacientes operados descritos na literatura.

. As crianças que permaneceram obstruídas por 1 ano também tiveram um crescimento facial predominantemente horizontal.

. É necessária uma revisão das conclusões previamente apresentadas na literatura sobre o impacto da desobstrução cirúrgica das vias aéreas superiores sobre o padrão de crescimento facial vertical.

APÊNDICES E ANEXOS

Apêndice 1 – Termo de Consentimento Livre e Esclarecido

Título do projeto: O impacto da desobstrução cirúrgica das vias aéreas superiores no crescimento e desenvolvimento dento-facial, em dois estágios da maturação biológica das crianças.

Objetivo do estudo: O objetivo do estudo é avaliar o impacto da desobstrução cirúrgica das vias aéreas superiores no crescimento e desenvolvimento dento-facial de crianças do projeto do Respirador Oral do HC-UFMG, em dois estágios de maturação.

Procedimentos: Se você concordar em participar deste estudo, os dados coletados nos exames feitos no Projeto do Respirador Oral do HC-UFMG, do menor sob sua responsabilidade, serão utilizados para efeito deste estudo. Os exames são: anamnese, fibronasoscopia, medição da resistência nasal inspiratória nasal e bucal, modelos ortodônticos de gesso, radiografia de mão e punho, radiografia panorâmica, telerradiografia em norma lateral da face, fotografias intra e extra bucais, questionário sobre os sinais e sintomas pós-cirúrgicos.

Riscos e desconfortos: Você ou o menor sob a sua responsabilidade não serão expostos a riscos. A criança deverá seguir a rotina de consultas e exames indicados pelo médico e/ou dentista assistente.

Benefícios: A realização deste estudo vai ajudar na compreensão da correlação entre o momento da desobstrução cirúrgica das vias aéreas superiores e o impacto sobre o crescimento e desenvolvimento dento-facial. Assim, poderemos indicar qual é o melhor momento de indicar as cirurgias desobstrutivas, do ponto de vista ortodôntico. Você não receberá nenhum pagamento e não terá custos para que o menor, sob a sua responsabilidade, participe deste estudo.

Possíveis dúvidas sobre o estudo: Este consentimento explica o estudo. Por favor, leia-o cuidadosamente. Pergunte sobre qualquer ponto que não tenha entendido. Se não tiver dúvidas agora, pode perguntar mais tarde. Durante o estudo, você será informado sobre qualquer fato novo que possa influenciar seu desejo de continuar participando. Se você desejar falar com alguém sobre este estudo por julgar que não recebeu um tratamento adequado ou que foi prejudicado ao participar, ou se tiver qualquer outra questão relativa ao estudo, você deve telefonar para os pesquisadores: Dr. Bernardo Quiroga Souki (xx-31) 3286-5108, Dra. Helena Becker (xx-31)3248-9583 ou Dr. Jorge Andrade Pinto (xx-31) 32489822, ou para o Comitê de Ética da UFMG (xx-31) 3248-9364.

A UFMG não tem nenhum programa para reembolsá-lo na ocorrência de danos ou acidentes que não são de responsabilidade dos médicos e pesquisadores.

Confidencialidade das informações: As informações obtidas serão mantidas nos limites de confidencialidade garantidos pela lei. Entretanto, a legislação obriga a notificação de doenças infecciosas e maus tratos infantis. Em certas situações, pessoas responsáveis por assegurar que o estudo foi conduzido apropriadamente poderão rever os seus dados. Estas pessoas manterão seus dados confidenciais. Pessoas não envolvidas no estudo não terão acesso a nenhuma de suas informações pessoais a não ser que você dê permissão.

Participação voluntária no estudo: Você (o menor sob a sua responsabilidade) não é obrigado a participar deste estudo e pode desistir a qualquer momento. Se decidir não participar, sua relação com os médicos e dentistas não será modificada de nenhuma forma.

O que significa a sua assinatura: Ao assinar este documento, você demonstra ter entendido as informações sobre o estudo e estar disposto a participar do projeto descrito na página anterior.

VOCÊ RECEBERÁ UMA CÓPIA DESTE CONSENTIMENTO

_______________________________________ __/___/___
Assinatura da criança (se aplicável) Data

_______________________________________ __/___/___
Assinatura do pai/mãe ou responsável legal Data

_______________________________________ __/___/___
Assinatura do pesquisador Data

_______________________________________ __/___/___
Assinatura da testemunha Data

Observação: Cópias assinadas deste consentimento deverão ser a) arquivadas pelo pesquisador principal, b) anexadas ao prontuário do paciente e c) fornecidas ao paciente.

Apêndice 2 – Dados brutos do Artigo 1

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1	3,4	2	2	2	1	2	3	2
1	7,7	1	2	1	2	2	3	1
2	9,6	1	3	1	2	1	3	1
1	5,1	1	2	3	1	3	3	2
1	2,4	1	9	1	1	4	3	2
2	8,3	1	3	1	2	2	1	1
1	7,2	3	3	1	2	1	1	1
1	5,1	3	3	2	2	3	4	2
2	4,6	1	3	1	1	3	3	1
1	3,7	1	2	1	1	2	3	1
1	3,0	3	3	1	1	3	3	9
1	2,5	9	9	9	9	3	2	2
1	2,6	2	3	3	1	4	2	2
2	5,7	9	9	9	9	3	4	9
1	5,3	3	3	1	1	2	5	2
1	7,4	1	4	1	2	3	2	1
2	5,9	3	3	2	2	2	3	2
2	6,2	1	4	1	2	1	3	1
2	10,2	9	9	9	9	2	3	1
2	8,9	1	3	1	2	2	1	1
2	8,8	1	2	1	2	3	2	1
2	4,0	1	2	1	1	3	3	1
1	7,5	9	3	2	2	1	1	9
1	3,0	9	9	9	9	3	4	2
2	12,3	1	3	1	2	1	3	9
1	6,9	9	4	1	2	1	5	9
2	9,6	1	2	1	2	1	3	1
2	8,6	9	2	3	2	1	1	1
1	9,3	9	2	3	2	3	3	2
1	8,1	1	3	1	2	1	3	2
1	11,5	1	2	3	3	1	1	1
1	6,1	2	2	1	1	1	1	2
2	5,4	9	3	1	2	2	3	1
1	7,9	1	4	1	2	3	3	2

1	7,3	1	3	2	2	2	4	1
1	4,4	3	3	1	1	3	4	2
1	5,0	1	2	1	1	3	3	1
1	6,6	9	3	3	2	3	4	1
2	4,3	1	2	1	1	3	3	2
1	10,4	1	3	2	2	1	1	1
2	5,3	1	4	3	1	4	3	2
1	4,0	1	2	1	1	3	3	1
1	1,7	9	9	9	9	2	3	1
2	6,4	1	9	3	1	2	3	1
2	5,3	9	9	9	9	3	4	9
2	10,4	1	2	1	2	4	1	9
2	7,5	9	2	1	2	4	1	9
1	9,7	3	4	9	2	1	1	9
1	2,5	9	9	9	9	2	3	9
1	4,4	3	2	1	1	3	4	9
1	3,7	2	3	1	1	4	4	9
1	7,5	1	3	1	2	3	1	9
1	15,3	1	2	1	2	3	3	9
1	9,3	2	2	1	2	2	3	9
2	6,3	1	2	1	2	1	1	1
2	10,6	1	2	1	2	1	3	9
2	5,8	1	3	1	2	1	2	9
1	2,9	1	2	1	2	2	4	9
1	6,7	1	1	1	2	2	4	9
2	4,5	1	1	1	1	2	3	9
2	10,5	1	4	1	3	1	2	9
2	5,4	9	9	9	9	1	2	1
2	8,7	1	2	1	2	1	3	9
2	4,2	3	2	3	1	2	3	9
2	10,2	1	2	1	2	1	2	9
1	4,1	3	3	1	1	1	2	1
1	4,8	1	2	1	1	3	3	1
1	6,6	1	1	1	2	2	1	9
1	7,8	2	2	1	2	1	1	2
1	2,3	2	3	1	1	2	3	2
2	11,1	2	2	1	3	1	1	1
1	8,9	3	3	1	2	1	1	9
2	5,7	2	2	1	2	2	4	1
2	9,5	3	2	1	2	2	2	1
2	5,4	1	2	1	1	3	4	1
1	5,1	1	3	1	1	4	1	2
1	5,6	2	3	1	2	1	1	1
1	4,7	1	2	1	1	3	4	2
1	7,2	3	4	3	2	3	3	1
1	7,4	3	9	1	2	1	3	1
2	4,0	9	9	9	1	3	1	9
1	6,2	2	3	1	1	4	2	1
1	2,4	9	9	9	1	3	4	2
2	7,2	1	3	1	2	3	3	9
1	9,1	1	4	1	2	2	4	1
2	8,6	1	3	1	2	1	1	1
2	9,8	1	2	2	2	4	2	2

1	5,7	1	2	1	2	3	5	1
2	9,3	3	2	1	2	1	3	1
1	5,0	1	2	3	1	1	3	1
1	10,1	1	3	1	2	2	1	9
2	6,8	3	4	2	2	1	3	9
2	10,3	2	3	3	2	2	4	9
2	4,2	1	1	1	1	3	4	2
2	5,9	1	3	2	1	4	4	2
2	8,4	3	1	1	2	1	1	1
1	6,2	3	3	3	2	1	4	9
1	7,9	2	2	9	2	2	1	2
2	7,4	1	2	1	2	4	2	2
1	2,1	1	1	1	1	2	3	1
1	6,3	3	2	2	2	5	1	1
1	5,2	1	3	1	1	3	2	1
2	8,1	2	2	1	2	4	3	1
2	11,0	2	2	1	2	1	1	9
1	3,5	9	9	9	1	2	3	1
1	9,2	1	2	1	2	2	1	1
2	4,3	3	2	1	1	2	1	2
1	5,3	1	2	3	1	2	4	9
2	7,1	9	9	9	9	2	4	1
1	8,8	1	1	1	2	2	4	1
2	4,5	1	1	1	1	2	3	9
2	9,8	1	2	1	2	1	1	1

Legenda:

Gênero: 1 (masculino), 2(feminino)

Vert (relação vertical): 1 (normal), 2 (mordida profunda), 3 (mordida aberta anterior)

Sag (relação sagital): 1 (normal), 2 (classe I), 3 (classe II), 4 (classe III)

Trans (relação transversal: 1 (normal), 2 (mordida cruzada posterior, 3 (mordida cruzada posterior com desvio

Dent (dentadura): 1 (decídua), 2 (mista), 3 (permanente)

Amigd (amigdala): 1 (grau 1), 2 (grau 2, 3 (grau 3), 4 (grau 4), 5 (não avaliada)

Adenoid (adenóide): 1 (<60%), 2 (60%-75%), 3 (75%-90%), 4 (>90%, 5 (não avaliada)

Rinite: 1 (presente), 2 (ausente), 9 (não avaliada)

Apêndice 3 – Dados brutos dos Artigos 2 e 3

Genero	Dent	Idade	Cirurgia	SBLPM 1	NLPM 1	SBLGo 1	SBLMe 1	NLMe 1	SBLPM 2	NLPM 2	SBLGo 2	SBLMe 2	NLMe 2	RotReal	RotApa
2	2	9,8	2	37,0	39,0	69,0	113,5	67,0	36,5	36,0	71,0	117,0	69,0	0,0	-0,6
1	2	7,4	2	37,5	28,0	65,0	104,0	59,0	37,0	27,0	64,0	106,0	58,0	-3,3	-0,5
2	2	6,8	1	44,0	35,0	59,0	100,0	58,0	44,0	33,0	60,0	104,0	59,0	0,5	0,0
2	2	9,0	1	45,0	32,0	61,0	104,0	56,5	45,0	30,0	62,0	107,0	58,0	-1,7	0,0
2	2	7,7	1	44,0	40,0	65,5	111,0	66,0	44,0	39,0	67,0	114,0	67,0	1,1	0,0
1	1	4,3	1	40,0	37,0	53,0	87,0	51,0	41,0	35,0	56,5	94,0	55,0	-0,7	1,5
1	2	6,3	2	47,0	37,0	61,5	106,5	57,5	48,5	35,0	62,0	109,5	59,0	0,0	1,7
1	2	7,8	1	38,0	33,0	73,5	113,0	63,0	40,0	31,5	74,0	115,0	63,0	4,5	3,0
1	2	5,9	1	49,0	39,0	54,0	100,0	62,0	48,0	39,0	54,0	102,0	62,5	-4,0	-1,3
1	2	10,9	2	40,0	33,0	68,5	113,0	62,0	40,0	33,0	70,0	117,0	64,0	-0,8	0,0
1	1	5,3	2	44,0	32,0	64,0	102,0	57,0	43,0	33,5	67,0	107,0	59,0	-2,1	-1,1
1	2	9,2	2	37,5	30,0	65,5	102,0	57,0	37,0	31,0	66,0	105,0	58,0	-1,0	-0,5
1	1	4,7	2	40,0	37,5	59,0	93,0	57,5	39,5	40,0	59,5	95,0	58,0	-0,1	-0,1
2	1	3,6	1	41,5	33,0	57,0	87,0	51,0	42,0	34,0	59,5	92,0	53,0	1,1	0,5
2	1	5,6	2	41,0	33,0	59,5	100,0	57,5	42,0	33,5	61,0	103,0	58,5	0,0	1,1
1	2	10,5	1	52,5	33,5	63,5	117,5	71,0	54,0	38,5	63,0	120,0	72,0	0,0	2,2
1	1	6,6	2	41,0	33,0	64,5	107,5	61,5	43,5	34,0	67,0	113,0	64,5	0,5	2,3
2	2	8,1	2	46,0	35,0	62,5	107,0	60,0	45,0	33,0	64,0	110,0	63,0	-1,0	-1,0
2	2	8,1	1	38,5	31,0	65,0	107,0	61,0	39,0	30,0	65,0	109,0	63,0	-1,1	0,5
1	2	5,9	1	37,0	36,0	65,0	102,0	58,0	35,0	36,0	65,0	105,0	60,0	-2,6	-1,8
1	1	4,9	1	39,5	40,0	59,5	95,0	58,0	39,5	40,0	59,0	95,5	58,5	-0,8	0,0
1	1	5,4	1	47,0	32,0	58,0	97,0	55,0	48,0	32,0	58,0	100,0	57,0	1,1	1,1
2	1	4,1	1	34,5	30,0	62,0	93,5	54,0	34,0	31,0	66,0	100,0	59,0	0,8	-0,8
1	2	6,3	1	40,5	33,0	64,5	99,0	55,0	40,0	33,5	66,0	102,0	57,0	-3,4	-0,6
1	2	6,0	1	42,0	37,5	63,0	103,0	57,5	42,5	39,0	62,0	103,5	58,5	-2,5	0,4
2	2	6,8	1	40,5	33,5	61,0	105,0	58,0	41,0	34,0	62,5	108,0	60,0	0,0	0,7

1	1	5,7	1	47,0	37,0	60,0	104,0	56,0	47,0	37,0	61,5	106,5	57,5	-0,3	0,0
1	1	5,1	1	39,0	35,0	61,5	95,5	56,5	35,0	33,0	66,0	100,5	59,0	-5,6	-4,4
1	1	4,9	1	44,5	36,0	56,0	96,0	55,0	42,0	35,0	61,5	102,0	57,5	-1,6	-3,9
1	2	7,6	1	39,0	29,0	65,0	103,5	55,0	36,5	27,5	69,5	106,0	55,5	-7,6	-3,5
1	2	5,0	1	54,0	46,0	56,0	101,0	59,0	51,0	43,5	59,5	106,0	60,0	-1,6	-3,2
1	1	3,6	1	44,0	37,0	58,0	94,0	53,0	42,0	36,0	62,5	100,0	56,0	-1,4	-2,7
1	2	6,4	2	40,0	34,0	68,0	107,0	61,0	38,0	33,0	73,5	113,0	63,0	-2,7	-2,7
2	2	6,3	2	40,5	27,5	61,5	102,0	59,5	39,0	27,0	65,0	104,0	59,0	-1,8	-1,8
1	1	5,5	2	43,5	39,5	61,0	100,0	56,0	42,0	37,5	63,0	103,0	57,5	0,0	-0,7
2	2	6,2	1	36,5	34,0	60,0	96,0	53,0	36,0	33,0	62,5	97,0	52,0	0,0	-0,6
2	1	4,6	2	41,5	42,0	53,0	88,0	56,0	41,0	41,0	57,5	92,5	58,5	3,8	-0,6
1	1	4,3	1	46,5	40,0	64,0	99,0	56,0	46,0	38,0	66,0	102,0	57,0	1,2	-0,6
1	1	3,7	2	41,0	38,0	50,0	85,0	50,0	40,0	37,0	53,0	87,0	51,0	1,0	-0,5
1	2	9,6	2	53,0	37,0	61,0	114,5	70,0	52,5	33,5	63,5	117,5	71,0	-2,9	-0,5
1	2	8,7	2	32,0	29,0	72,0	104,0	56,0	32,5	28,0	74,0	106,0	56,0	3,0	0,5
1	2	5,9	2	49,0	37,0	54,0	102,0	62,0	50,0	36,0	56,5	106,0	64,0	1,1	0,6
1	1	5,3	2	47,0	37,0	59,0	102,0	60,5	48,0	36,0	61,0	105,0	62,0	0,6	0,6
1	2	7,6	2	41,0	32,0	62,5	102,5	58,5	39,0	32,0	67,5	107,0	61,0	-2,0	-2,6
2	2	8,3	2	47,5	32,0	57,5	101,0	56,0	45,0	32,0	61,0	104,0	56,5	-2,7	-1,7
1	2	6,0	1	42,0	34,0	65,5	103,0	62,0	38,0	35,0	70,0	108,0	61,5	-6,3	-5,0
1	1	4,0	2	39,0	33,0	61,0	100,0	57,0	37,0	35,0	66,0	105,5	60,0	-7,0	-2,8
1	2	7,2	2	41,0	29,0	70,0	114,0	62,0	40,0	30,0	70,5	114,0	61,0	-1,5	-0,5
2	2	9,2	1	39,0	30,0	65,0	109,0	63,0	38,0	30,5	68,0	113,0	64,0	0,2	-0,3
2	1	5,9	2	39,0	29,0	65,0	103,0	60,0	39,0	30,0	67,0	106,0	61,0	-2,5	0,0
1	2	8,6	2	38,0	29,0	69,0	110,0	64,0	38,0	31,0	72,0	112,0	64,0	1,0	0,0
2	2	6,3	2	37,0	31,0	59,5	100,0	55,5	37,5	34,0	61,0	101,0	54,5	-2,1	0,5
1	2	7,3	1	48,0	36,0	61,0	105,0	62,0	46,5	34,0	64,0	110,0	65,0	-2,6	-1,9
1	2	6,0	1	37,0	35,0	66,0	105,5	60,0	35,0	35,0	69,0	105,5	60,0	-6,8	-2,3
1	1	6,2	2	44,0	35,0	63,0	104,0	57,5	39,5	33,0	68,0	109,0	61,5	-5,7	-6,4
2	1	3,5	1	36,5	27,5	56,5	88,0	50,0	35,0	27,0	61,5	94,0	54,0	-3,8	-1,9
2	2	9,4	2	44,0	38,0	68,0	112,0	64,0	43,0	35,0	72,5	115,0	66,0	-1,6	-1,1
2	2	8,8	1	40,0	37,0	66,0	107,0	55,5	39,0	35,0	68,5	109,5	57,5	1,0	-1,0

2	1	5,3	1	43,0	35,0	55,5	94,0	54,0	42,5	33,0	57,5	97,0	56,0	-1,1	-0,5
2	2	6,1	2	44,5	37,0	57,0	98,5	57,0	44,0	35,0	59,0	100,0	58,0	-1,1	-0,3
1	2	7,8	1	40,0	30,0	70,5	114,0	61,0	40,0	26,0	74,0	114,0	66,0	-2,7	0,0
1	1	6,7	1	37,0	31,0	63,0	103,5	58,0	42,0	30,0	66,0	108,0	61,0	2,1	5,2
1	2	6,5	1	50,0	36,0	56,5	106,0	64,0	47,0	36,0	59,0	107,0	65,0	-0,8	-2,5
1	1	5,1	2	43,0	34,0	61,0	100,0	57,5	42,0	34,0	65,5	103,0	60,0	0,0	-0,9
2	2	9,5	1	35,0	27,0	72,0	114,5	63,5	35,0	27,0	77,5	117,0	65,0	-2,1	0,0
1	2	6,9	1	37,0	30,0	61,0	96,0	54,0	37,0	30,0	63,0	99,0	56,0	-2,1	0,0
1	2	7,2	1	35,0	30,0	72,5	108,5	58,0	36,0	30,0	75,0	112,0	60,0	3,9	1,3
1	2	10,6	1	45,0	32,5	70,0	115,0	64,0	43,5	33,0	75,0	120,0	67,5	-2,7	-2,0
2	2	10,2	1	53,0	37,0	66,5	117,0	67,0	53,0	38,5	70,0	122,0	72,0	0,0	0,0
1	1	4,8	2	36,0	34,0	61,0	96,0	54,0	37,0	36,0	65,0	102,0	58,0	0,5	1,1

Anexo 1: Cópia da aprovação do projeto no Comitê de Ética em Pesquisa da Universidade Federal de Minas Gerais.

UFMG

Universidade Federal de Minas Gerais
Comitê de Ética em Pesquisa da UFMG - COEP

Parecer nº. ETIC 488/06

Interessado (a): Prof. Jorge Andrade Pinto
Depto. De Pediatria
Faculdade de Medicina - UFMG

DECISÃO

O Comitê de Ética em Pesquisa da UFMG – COEP, aprovou, no dia 28 de março de 2007, após atendidas as solicitações de diligência, o projeto de pesquisa intitulado **"O impacto da desobstrução cirúrgica das vias aéreas superiores no crescimento e desenvolvimento dento-facial, em dois estágios da maturação biológica das crianças"** bem como o Termo de Consentimento Livre e Esclarecido do referido projeto.

O relatório final ou parcial deverá ser encaminhado ao COEP um ano após o início do projeto.

Profa. Dra. Maria Elena de Lima Perez Garcia
Presidente do COEP/UFMG

Av. Antonio Carlos, 66270 – Unidade Administrativa II - 2º andar - Sala 2005 - 31270-901 – BH - MG

Anexo 2: Artigo 1 – versão impressa da Revista *International Journal of Pediatric Otorhinolryngology*.

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Prevalence of malocclusion among mouth breathing children: Do expectations meet reality?

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A B S T R A C T

Objective: The aim of this study was to report epidemiological data on the prevalence of malocclusion among a group of children, consecutively admitted at a referral mouth breathing otorhinolaryngological (ENT) center. We assessed the association between the severity of the obstruction by adenoids/tonsils hyperplasia or the presence of allergic rhinitis and the prevalence of class II malocclusion, anterior open bite and posterior crossbite.

Methods: Cross-sectional, descriptive study, carried out at an Outpatient Clinic for Mouth-Breathers. Dental inter-arch relationship and nasal obstructive variables were diagnosed and the appropriate cross-tabulations were done.

Results: Four hundred and one patients were included. Mean age was 6 years and 6 months (S.D.: 2 years and 7 months), ranging from 2 to 12 years. All subjects were evaluated by otorhinolaryngologists to confirm mouth breathing. Adenoid/tonsil obstruction was detected in 71.8% of this sample, regardless of the presence of rhinitis. Allergic rhinitis alone was found in 18.7% of the children. Non-obstructive mouth breathing was diagnosed in 9.5% of this sample. Posterior crossbite was detected in almost 30% of the children during primary and mixed dentitions and 48% in permanent dentition. During mixed and permanent dentitions, anterior open bite and class II malocclusion were highly prevalent. More than 50% of the mouth breathing children carried a normal inter-arch relationship in the sagital, transversal and vertical planes. Univariate analysis showed no significant association between the type of the obstruction (adenoids/tonsils obstructive hyperplasia or the presence of allergic rhinitis) and malocclusions (class II, anterior open bite and posterior crossbite).

Conclusions: The prevalence of posterior crossbite is higher in mouth breathing children than in the general population. During mixed and permanent dentitions, anterior open bite and class II malocclusion were more likely to be present in mouth breathers. Although more children showed these malocclusions, most mouth breathing children evaluated in this study did not match the expected "mouth breathing dental stereotype". In this population of mouth breathing children, the obstructive size of adenoids or tonsils and the presence of rhinitis were not risk factors to the development of class II malocclusion, anterior open bite or posterior crossbite.

1. Introduction

The association between nasal respiratory impairment and dento-facial morphology has been studied for more than a century [1–3] and for decades it has been strongly accepted that inter-arch growth pattern can be influenced by an unbalanced muscular function on mouth breathers [4].

The knowledge that obstruction of nasal breathing most likely will perversely impact the facial growth even led some authors to propose classic terms to describe such patients as "adenoid faces" [5], "long face syndrome" [6] and "respiratory obstruction syndrome" [7].

A stereotype of these patients, therefore, can be drawn, where an anterior open bite [8], a reduced transversal dimension [9,10], associated or not with posterior crossbite [11], and a class II malocclusion [12–14] are expected.

However, as individual facial genotypes have different sensitivity on developing malocclusion, following the exposure to mouth breathing, a wide variety of inter-arch relationships can be found.

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The emphasis on this mouth breathing stereotype has been unfortunate because it implies that all patients with those clinical findings are mouth breathers and that nasal impaired respiration will ultimately result in this malocclusion. Besides that, one question arises: can we predict the outcome of these malocclusions based on the presence and on the type of airway obstructive cause which led to this deleterious habit?

Routinely, Ear, Nose and Throat (ENT) specialists and general clinicians use the diagnosis of the airflow blockage by adenoids and tonsils hyperplasia as a parameter to the establishment of the treatment planning [15]. Although this axiom has been used routinely by clinicians, it has not been sufficiently tested regarding the development of malocclusion.

The aim of this study was to report epidemiological data on the prevalence of malocclusion among a group of children, consecutively admitted at a referral mouth breathing ENT center. We assessed the association between severity of the obstruction by adenoids/tonsillar hyperplasia or the presence of allergic rhinitis and the prevalence of class II malocclusion, anterior open bite and posterior crossbite.

2. Patients and methods

2.1. Population

Four hundred and forty four children consecutively referred by pediatricians and primary care physicians to the Outpatient Clinic for Mouth-Breathers, at the Hospital das Clínicas at Federal University of Minas Gerais (UFMG), Brazil, between November of 2002 and November of 2007, with the chief complaint of mouth breathing were systematically evaluated by a multidisciplinary team comprised by ENT doctors, allergologists and orthodontists, in a single day visit.

Children whose mouth breathing could not be confirmed, those who have had previous orthodontic treatment or were younger than 2 years of age were excluded from the analysis. Therefore, the sample of this cross-sectional study totaled 401 patients.

All subjects were evaluated by otorhinolaryngologists to confirm mouth breathing resulting from at least one of the following airway pathologies: obstructive tonsillar hyperplasia, obstructive adenoidal hyperplasia and allergic rhinitis. The children whose obstruction by one of these conditions could not be diagnosed were classified as functional mouth breathers [16].

The participant's rights were protected, and informed consent and assent were obtained according to the Ethics Committee of the Federal University of Minas Gerais.

2.2. ENT data collection

An interview with children's parents, or guardians, asking about the quality of the children's sleep, snoring, oral breathing and throat infections, confirmed the "chief complaint" of mouth breathing. Parents were also asked if the child had been undergone an adenoidectomy or tonsillectomy earlier. Clinical ENT examination was performed by two of the authors (L.F. and H.B.), according to the following guidelines.

Palatine tonsil hypertrophy was classified by mouth examination according to the criteria of Brodsky and Koch [17] as follows: grade 0, tonsils limited to the tonsillar fossa; grade 1, tonsils occupying up to 25% of the space between the anterior pillars in the oropharynx; grade 2, tonsils occupying 25–50% of the space between the anterior pillars; grade 3, tonsils occupying 50–75% of the space between the anterior pillars; and grade 4, tonsils occupying 75–100% of the space between the anterior pillars.

Tonsils grade 0, 1 and 2 were considered as non-obstructive and those classified as grade 3 and 4 were named as obstructive [18].

Adenoids were assessed by flexible nasoendoscopy and were grouped into two categories based on nasopharyngeal obstruction ($<$75% and $\geq$75%). A cut-point of 75% was chosen to classify the blockage of the nasopharynx as obstructive or non-obstructive [19].

2.3. Allergological data collection

The allergological assessment, to diagnose allergic rhinitis, included a structured medical interview, physical examination, following the standard volar forearm skin prick method, as described elsewhere [20]. These exams were performed in 326 children under the supervision of one of the authors (J.P).

2.4. Dental data collection

The dental clinical examination was performed by a team of orthodontists, who worked together for at least 10 years, and were previously calibrated. The subjects were grouped by stage of dental development, according to the variation in primary and permanent teeth eruption, into deciduous, mixed and permanent periods.

The inter-arch occlusion dental classification was based on Barnett [21]:

Vertical: relationship was classified as (1) normal, (2) anterior open bite or (3) deep bite. An open bite was registered in cases that lacked any overbite, regardless of the amount. A deep bite was registered when more than half of the lower incisors were overlapped by the incisal edges of the upper incisors.
Transversal: relationship was classified as (1) normal, (2) posterior crossbite, without mandibular functional shift, and (3) posterior bite, with mandibular functional shift.
Sagital: relationship was classified as (a) normal occlusion, (b) class I malocclusion, (c) class II malocclusion and (d) class III malocclusion. During the deciduous and mixed dentitions, it was considered a class I dental relationship when the upper deciduous cuspid intercuspation was set between the lower deciduous cuspid and first deciduous molar. When in permanent dentition the Angle classification was followed.

2.5. Dental data comparison

A large number of studies on the prevalence of malocclusion in different populations have been published. These data served as a reference of what should be the distribution on inter-arch anomalies among a general population, where mouth and nasal breathers were sampled together [28–32,35–41].

2.6. Statistics

Epi-data was used to enter data. SPSS version 12.0 was used for the analysis. Descriptive statistics and univariate analysis in cross-tables are showed. The significance level of $p < 0.05$ was chosen. Normality of age distribution was tested using Kolmogorov–Smirnov test.

For each dental and ENT variable, the number of children with the diagnosed status (n) and its prevalence (%) are given.

For the purpose of statistical analysis, dental variables were binarily grouped according to the expected inter-arch relationships in mouth breathing subjects. Therefore the dependent variables examined were class II malocclusion, anterior open bite and posterior crossbite.

The independent ENT variables were the obstructive grade of tonsil and adenoids and the presence of rhinitis.

3. Results

The mean age of this sample was 6 years and 6 months and the standard deviation was 2 years and 7 months. The age of the children ranged between 2 and 12 years. With the exception of 38 children (9.5%), whose mouth breathing was due to functional habit, 363 subjects had an objective airway obstructive factor. Of these children, 288 (71.8%) were judged to have tonsil and/or adenoid obstruction, combined or not with rhinitis. Allergic rhinitis, as the only obstructive cause, was found in 75 children (18.7%).

Table 1 shows the prevalence of the studied variables, by gender. As there was no gender statistically difference ($p > 0.05$), the analysis was done considering boys and girls as a single group.

As seen in Table 1, the majority of the children was within the deciduous (41.4%) or mixed (52.1%) dentitions. In this growth period of their lives, they were susceptible to the unbalanced muscular adaptation to mouth breathing. Only few children (6.5%) were in permanent dentition.

Based in Table 1, 58.1% of the sample had a normal sagital relationship (class I dental relationship). Class I malocclusion was found in 46.9% of these children, the other 11.2% represents the normal occlusion children. Regarding the three stages of occlusal development (Table 2), Class I dental relationship was found in 64.2% during deciduous dentition, 53.8% and 54.2% during mixed and permanent dentitions, respectively.

About 42% of this sample presented with a sagital disharmony, represented by class II or III. The prevalence of class III gets higher as kids get older (Table 1).

Considering the 384 children whose sagital classification was done, dental Class II was the sagital relationship of 27% during primary dentition, 32.8% on mixed dentition and 25% on permanent dentition (Table 2).

The vertical inter-arch relationship must be studied in the dental stage of development because of its known physiologic difference along the growing period. Nevertheless, Table 2 brings the information that a normal vertical relationship was found in, at least, 52.7% of the sample, regardless of the dental stage of development. Open bite prevalence was around 30% during the deciduous and mixed dentitions and 20% in permanent dentition.

In the transversal analysis, posterior crossbite was detected in close to 30% of the kids during deciduous and mixed dentitions and 48% in permanent dentition (Table 2).

All comparisons in Table 2 demonstrate that there is no difference in the malocclusion occurrence when comparing the three stages of dental development (p values >0.05).

Regarding the tonsils (Table 1), the more obstructing grades (3 and 4) were found in about 40.9% of the kids, but considering the stratified groups by age (Table 2), kids during early stages

Table 1
Prevalence of dental and ENT findings according to gender distribution. Number of children (n) and prevalence given in percentage ($n/N \times 100\%$).

Variables	Boys		Girls		Total	
	n	%	n	%	n	%
Stage of development (N = 401)						
Deciduous dentition	106	26.4	60	15.0	166	41.4
Mixed dentition	110	27.4	99	24.7	209	52.1
Permanent dentition	12	3.0	14	3.5	26	6.5
χ^2 = 6.050 (2 d.f.) p value = 0.05						
Sagital relationship (N = 384)						
Normal occlusion	26	6.8	17	4.4	43	11.2
Class I malocclusion	97	25.3	83	21.6	180	46.9
Class II malocclusion	64	16.7	51	13.3	115	29.9
Class III malocclusion	30	7.8	16	4.2	46	12.0
χ^2 = 2.230 (3 d.f.) p value = 0.526						
Vertical relationship (N = 385)						
Normal	115	29.9	98	25.5	213	55.3
Deep bite	38	9.9	21	5.5	59	15.3
Open bite	67	17.4	46	11.9	113	29.4
χ^2 = 2.349 (2 d.f.) p value = 0.309						
Transversal relationship (N = 392)						
Normal	158	40.3	116	29.6	274	69.9
Posterior crossbite w/o shift	31	7.9	22	5.6	53	13.5
Posterior crossbite w shift	32	8.2	33	8.4	65	16.6
χ^2 = 1.631 (2 d.f.) p value = 0.443						
Tonsils status (N = 399)						
Grades 0, I, II	141	35.3	95	23.8	236	59.1
Grades III, IV	86	21.6	77	19.3	163	40.9
χ^2 = 1.918 (1 d.f.) p value = 0.166						
Adenoid obstruction status (N = 390)						
<75%	95	24.4	70	17.9	165	42.3
≥75%	124	31.8	101	25.9	225	57.7
χ^2 = 0.235 (1 d.f.) p value = 0.628						
Rhinitis (N = 326)						
Yes	133	40.8	102	31.3	235	72.1
No	51	15.6	40	12.3	91	27.9
χ^2 = 0.008 (1 d.f.) p value = 0.928						

Table 2
Prevalence of dental and ENT findings in the deciduous. Mixed and permanent dentitions. Number of children (n) and prevalence given in percentage ($n/N \times 100\%$).

Variable	Deciduous		Mixed		Permanent	
	n	%	n	%	n	%
Dental						
Sagital relationship (N = 384)	159		201		24	
Normal occlusion	24	15.1	19	9.5	1	4.2
Class I malocclusion	78	49.1	89	44.3	12	50.0
Class II malocclusion	43	27.0	66	32.8	6	25.0
Class III malocclusion	14	8.8	27	13.4	5	20.8
χ^2 p value = 0.196						
Vertical relationship (N = 385)	165		195		25	
Normal	87	52.7	111	56.9	15	60.0
Deep bite	27	16.4	27	13.8	5	20.0
Open bite	51	30.9	57	29.2	5	20.0
χ^2 p value = 0.731						
Transversal relationship (N = 392)	164		203		25	
Normal	118	72.0	143	70.4	13	52.0
Posterior crossbite w/o shift	19	11.6	29	14.3	5	20.0
Posterior crossbite w shift	27	16.5	31	15.3	7	28.0
χ^2 p value = 0.314						
ENT						
Tonsils status (N = 399)	165		208		26	
Grades 0, I, II	83	50.3	133	63.9	20	76.9
Grades III, IV	82	49.7	75	36.1	6	23.1
χ^2 p value = 0.005						
Adenoid obstruction status (N = 390)	161		205		24	
<75%	43	26.7	102	49.8	20	83.3
≥75%	118	73.3	103	50.2	4	16.7
χ^2 p value = 0.000						
Rhinitis (N = 326)	137		168		21	
Yes	79	57.7	136	81	20	95.2
No	58	42.3	32	19	1	4.8
χ^2 p value = 0.000						

Note: χ^2 based on $n \times 3$ tables. n = variable.

Table 3
Univariate analysis between grouped malocclusion (dependent variable) and the obstructive causes for mouth breathing (independent variables).

Variables	Tonsil/adenoid obstruction	Rhinitis only	No obstructive cause diagnosed	*p* value
Class II malocclusion				
Yes	78	24	13	0.589
No	196	49	24	
Anterior open bite				
Yes	79	24	10	0.710
No	198	48	26	
Posterior crossbite				
Yes	85	26	7	0.242
No	197	48	29	

(deciduous dentition) had a higher prevalence (49.7%) than latter stages (36.1% and 23.1% during mixed and permanent dentitions, respectively). Table 2 also illustrate that the distribution of tonsillar obstruction shifted according to aging. Children during the deciduous dentition stage of development have more obstructive tonsils than older ones ($p < 0.05$).

The adenoid's obstruction of the nasopharynx showed similar epidemiological behavior. Although the average prevalence of the obstructive group (≥75% occupation of nasopharynx space) was 57.7% (Table 1), when analyzing this variable under the perspective of dental stage of development, it is clear that prevalence declines steeply from 73.3% to 16.7% along the aging (Table 2), with statistically significant difference ($p < 0.05$).

The overall prevalence of allergic rhinitis was 72.1% ($n = 235/326$), as demonstrated in Table 1. During mixed and permanent dentitions the proportion of subjects with rhinitis was bigger (81% and 95.2%, respectively) than in deciduous dentition 57.7% (Table 2), a statistically significant difference ($p < 0.05$).

Table 3 shows the univariate analysis between grouped malocclusion (dependent variable) and the ENT independent variables. No association was found between the expected type of malocclusion for mouth breathers and the presence of variables that obstruct the nasal airflow ($p > 0.05$).

The comparison between our findings and the literature data inter-arch prevalence is done in Section 4.

4. Discussion

Several reports have associated mouth breathing with dental malocclusion. The first papers were limited to clinical impressions of dentistry pioneers who related the disturbance on facial and occlusal harmony to the impairment of nasal breathing in their patients. Later, many papers published reports based on the findings of scientific data collection, mostly considering the skeletal outcome evaluated by cephalometry. However, data on occlusal clinical parameters of mouth breathing children are scarce.

Dental inter-arch relationship, in the three planes of space, is the basic clinical parameter in understanding the patient's occlusion and its behavior when exposed to unbalanced muscular activity. Therefore, it is important to assess the occurrence of occlusal disorders among mouth breathing children.

Despite the large sample size of this study, the limitations of a cross-sectional design needs to be considered. As our sample is comprised only of mouth breathers, the prevalence of dental inter-arch status had to be compared with other epidemiological reports on a general population [28–32,35–41]. This methodology brings at least two biases: (1) it is fact that in a general population a significant number of children are mouth breathers [22–24]. Thus, the difference between the prevalence of malocclusion in this mouth breathing population and a "normal breathing" population would be greater. (2) The reported prevalence varies considerably between the different studies, even among the same population. This divergence in prevalence figures may depend not only on differences for specific ethnic groups [25], but also on wide ranges in number and age among the examined subjects. However, differences in registration methods, i.e. the criteria for the recorded items, are probably the most important factor explaining these differences. Despite these methodological limitations, this study brings results that deserve further discussion.

Our study compared the prevalence of only one malocclusion in each plane of space: class II (sagital), anterior open bite (vertical) and posterior crossbite (transversal), since an occlusal pattern for mouth breathers is well described.

Anomaly studies usually report findings by chronological age. Malocclusion, however, is a manifestation that is related to development of the dentition. Given the great individual variations in dental maturation, it seems logical to determine the prevalence of malocclusion for groups at different stages of dental development, rather than for different age groups. It is interesting to point out that the pattern of distribution of the prevalence of malocclusions does not show any statistical difference among the three stages of dental development (Table 2), as it occurs in the general population [26]. It is expected that the prevalence of each malocclusion changes among the growth period. This fact suggests that in a mouth breathing population, the increase in the prevalence of some malocclusions alter the common pattern.

Regarding the sagital relationship, it is known that race impacts significantly the prevalence of classes I, II and III malocclusions [27]. Therefore, a good comparison is made only with Brazilian data. This was possible in the first two stages of dental development. During primary dentition, the prevalence of class II in our mouth breathing group was 27%. The prevalence found in previous publications in Brazil varies between 6.8% and 30% [28–30]. Our findings are quite similar to a large sample study ($n = 2139$) conducted by Tomita et al. [28]. However our prevalence is higher than found in other studies [29,30]. Kataoka et al. [29] concluded that the prevalence of class II in their sample was low (6.8%) because their population was comprised only by Japanese-Brazilian ethnic children. This fact, explains the difference between our findings. However, the difference in relation to the results found by Sadakyio et al. [30] (15.6%) can be justified by data collection methodology discrepancies or differences due to mouth breathing.

In mixed dentition, our study's class II prevalence (32.8%) is much higher than the 12.5% reported by Zanetti [31]. This significant discrepancy suggests that in older children, the perverse impact of mouth breathing, on sagital inter-arch development, is greater than on the deciduous dentition. Cheng et al. [11] noted that the younger a subject is, at the time of evaluation, the less the "adenoid" type of facial characteristics is expressed. This opinion corroborates our findings. We can hypothesize that the longer the exposure to the unbalanced muscular function, due to mouth breathing, the greater the risk of developing class II malocclusion. More epidemiological reports on sagital relationship during the mixed dentition stage would be helpful in testing this hypothesis, but only one was found. Longitudinal cohort studies are necessary to test if this hypothesis is correct.

During permanent dentition, the prevalence of class II in this sample was 25%. A comparison with Brazilian data was not possible because no epidemiological study involving general population at this stage was found, regarding this type of malocclusion. Comparing to Horowitz [32], who evaluated American subjects, the prevalence numbers (22.5%) are quite similar to our results. This observation corroborates the conclusions of Howard [33], Leech [34] and McNamara [3]. Nevertheless, comparing our permanent dentition class II findings with the classic study of Emrich et al. [35], also in the United States, who found 14%, our prevalence was higher. As the size of permanent dentition sample, in our study, was small ($n = 24$), we suggest that other studies, with larger samples, should test this association.

Regarding the vertical inter-arch relationship, the same type of association described to class II was found. Compared to the literature data, the prevalence of open bite during deciduous dentition, in the investigated mouth breathers, was quite similar. While our children's anterior open bite prevalence during deciduous dentition was 30.9%, the revised literature on general population varied between 20.6% and 46.3% [28,44–46]. But, when analyzing the older children (mixed dentition), an important difference was noted. The prevalence of open bite reported in the reference articles [31,36–39] varies between 12.00% and 20.1%, while our sample had a prevalence of 29.2%.

In the transverse dimension we found the most significant discrepancy in the prevalence of malocclusion. Dental literature data shows that the prevalence of posterior crossbite ranges from 8% to 22% [40]. Prevalence studies on posterior crossbite during permanent dentition are rare, but Thilander et al. [41] found a prevalence of 3.9% during this stage. Therefore we considered 22% as the top value. We found a prevalence of 30.1% of posterior crossbite in whole group. This prevalence of close to 30% in the primary and mixed dentitions and almost 50% in the permanent one is higher than in the general population and deserves additional consideration.

As the etiology of malocclusion has singular characteristics when considering the three different planes of space, this heterogeneity can help with the comprehension of our findings.

Sagital dental inter-arch relationship is mostly determined by heredity [27] and therefore mouth breathing is only a secondary etiological factor to class II development. Most likely, the power of the unbalanced muscular activities, due to mouth breathing, is not enough to shift a solid class I or III patterns into a class II. Maybe those children with a tendency toward a class II, who could growth into class I, depending on environmental factors, are the population candidates who develop class II, when exposed to mouth breathing. Therefore, in an epidemiological analysis, as we did, the prevalence of class II is higher than in the general population, especially in older children.

Vertical dental relationship also has heredity as the major determinant, but environmental factors such as non-nutritious sucking habits and mouth breathing work as secondary causes of anterior open bite [42]. During deciduous dentition, when sucking habits are highly prevalent in Brazil [43], the prevalence of anterior open bite found in our sample of nasal impaired children was within the range cited in previous Brazilian studies [40–42]. However, during mixed and permanent dentitions, as these sucking habits decline in the general population, the difference with our data gets bigger.

The transversal dental relationship, although governed by individual facial genotype [47], suffers greatly from environmental perverse factors [40]. Mocellin et al. [48], found 63.3% of palatal constriction in mouth breathers and 5% in nasal breathers. This fact explains why the discrepancy in the prevalence of posterior crossbite was so significant between the mouth breathers and the general population. As ethnic difference does not influence posterior crossbite [25], the comparison with data from other studies is feasible.

The triad of class II malocclusion, anterior open bite and posterior crossbite, despite showing a higher prevalence in a mouth breather sample than in the general population, is not the most prevalent inter-arch relationship among the studied nasal impaired children. In fact, a significant number of children showed a normal occlusion, even growing with this perverse habit.

It is clear that mouth breathing is capable of adding an environmental weight to the etiology of such malocclusions. However, since heredity plays a more important rule on facial growth and development, we should not expect to find, on an individual basis, many of these dental anomalies. It is not possible, therefore, to predict with any certainty whether or not a mouth breathing child will develop malocclusion, despite the fact that on an epidemiological level, mouth breathers have a higher risk of developing class II, anterior open bite and posterior crossbite than a general population, as shown in other studies [10].

The results of this study suggest that older mouth breathing children (mixed and permanent dentitions) have a tendency toward increasing the prevalence of class II malocclusion and open bite. If this assumption is true, normalizing nasal airflow passage in younger children, instead of postponing ENT treatments, would be beneficial from an orthodontic point of view. This hypothesis needs to be tested in a longitudinal design study.

Our data did not show any association between the prevalence of malocclusion and an obstructive pattern of the tonsils and/or adenoid, nor with the presence of allergic rhinitis. This is a controversial field in which previous studies have shown discordant findings [2,7,49–54].

An explanation of this finding is based on morphogenetic sensitivity in the development of malocclusion. If the child facial type is prone to the development of one or more of the studied inter-arch abnormalities, mouth breathing will only add an additional etiological "push", regardless of the severity or the type of the obstruction. Similarly, when a child has a low susceptibility to the development of malocclusion, even in the presence of a greater airflow obstruction, no dento-facial sequela will occur.

If this explanation represents the truth, the risk of developing malocclusion may be proportional to its morphogenetic susceptibility, but not with the severity of the obstruction. In this research, no evaluation of the skeletal pattern was done, which would allow the identification and stratification of the susceptibility. Therefore, it is only possible to speculate that a full spectrum of malocclusion was present. This balanced distribution contributed to the interesting results of no association between malocclusion and the grade of airflow blockage.

Secondly, another point which must be considered is the time lapse between the initiation of mouth breathing and the malocclusion outcome. If we theorize that, over time, children with greater obstruction could develop more malocclusion than children with less severity, using a young sample may explain the lack of association between the tested variables.

One more explanation to our results could be the chosen cut point which classified the tonsils and adenoids hyperplasia as being obstructive or not. As no validation of these clinical criteria was done yet, anyone can argue that a bias on the obstruction classification interfered with the results.

As it was expected, the younger children had more tonsils and adenoids obstruction than older ones [55]. The prevalence of rhinitis, however, was much higher in older children. The reason is linked to Waldeyer's ring involution with aging, consequently reducing the number of older subjects with adenoid or tonsil hyperplasia referred to the hospital. Thus the respiratory ENT complaint of older children tends to be rhinitis.

The findings of this study suggest that, based on the orthodontic point of view, ENT doctors should consider treating all mouth breathing children, regardless of the etiological factor, since it is not possible to identify the risk of developing malocclusion based solely on routinely used criteria.

Further research, with a longitudinal design and using methods that can help in the identification of morphogenetic sensitivity such as lateral cephalometric radiograph, and better evaluation of the severity of airway obstruction could add important information to this topic.

In conclusion, our study showed that the investigated nasal impaired children had a higher prevalence of posterior crossbite than general population at the same stage of development. During mixed and permanent dentitions, anterior open bite and class II malocclusion were more likely to be present in mouth breathers. However, the majority of the children did not match the expected ''mouth breathing dental stereotype''. We have also showed that, in this sample of mouth breathers, adenoids/tonsils hyperplasia or the presence of rhinitis, have no association with the prevalence of class II malocclusion, anterior open bite and posterior crossbite.

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Anexo 3: Aceitação do Artigo 2 pela Revista *International Journal of Pediatric Otorhinolryngology*.

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Ms. Ref. No.: IJPORL-D-09-00411R1
Title: Changes in vertical dentofacial morphology after adeno-/tonsillectomy during deciduous and mixed dentitions mouth breathing children - one year follow up study.
International Journal of Pediatric Otorhinolaryngology

Dear BERNARDO,

I am pleased to tell you that your work has now been accepted for publication in International Journal of Pediatric Otorhinolaryngology.

Thank you for submitting your work to this journal.

With kind regards,

Corina Cosgrave
Journal Manager
International Journal of Pediatric Otorhinolaryngology