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A EXPANSÃO RÁPIDA DA MAXILA MELHORA A APNEIA OBSTRUTIVA DO SONO EM ADULTOS? Uma revisão sistemática

Belo Horizonte
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Dissertação apresentada ao Programa de Pós-Graduação em Odontologia da Pontifícia Universidade Católica de Minas Gerais, como requisito parcial para obtenção do título de Mestre em Odontologia, Área de Concentração: Ortodontia.

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Orientador: Prof. Dr. Dauro Douglas Oliveira

Coorientador: Prof. Dr. Lucas Guimarães Abreu

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“O destino não é uma questão de oportunidade. É uma questão de escolha, não é algo pelo qual se deve esperar, é algo que deve ser perseguido.” (BRYAN).

RESUMO

A apneia obstrutiva do sono (AOS) acomete um percentual considerável da população e é caracterizada pela obstrução parcial ou total das vias aéreas durante o sono. A expansão rápida da maxila (ERM), procedimento vastamente utilizado pelos ortodontistas, é capaz de aumentar o volume das vias aéreas na região nasal. Não está claro na literatura se a ERM tem efeitos concretos na redução da AOS em adultos. O presente estudo, objetivou avaliar o nível de evidência científica disponível na literatura mundial a respeito do uso da ERM no tratamento da AOS em adultos por meio de uma revisão sistemática, seguindo os critérios estabelecidos pelo *Preferred Reporting Items for Systematic Reviews and Meta-Analysis* (PRISMA) e Cochrane *Handbook for Systematic Reviews of Interventions*. As bases de dados LILACS/Bireme, Medline/PubMed, Web of Science, Cochrane Clinical Trials e Scopus, foram pesquisadas em 2018 sem restrições de idioma ou data. A busca identificou 531 estudos, após aplicação dos critérios de elegibilidade, 11 estudos foram lidos na íntegra e dois foram selecionados para análise qualitativa da revisão sistemática. A análise do risco de viés, ROBINS, indicou sério risco de viés e ausência de informação nos artigos, respectivamente. A análise da qualidade da evidência e força de recomendação, realizada pelo sistema GRADE indicou um baixo nível de evidência. Uma meta análise não pode ser realizada devido a heterogeneidade dos estudos. Apesar das limitações relacionadas aos estudos incluídos na revisão, os estudos sugerem que a AOS melhorou ERM. Ensaios clínicos randomizados devem ser realizados para reunir evidências confiáveis.

Palavras-chave: Apneia obstrutiva do sono. Técnica de expansão palatina. Revisão sistemática.

ABSTRACT

Obstructive sleep apnea (OSA) is characterized by partial or total obstruction of the upper airway during sleep and affects a considerable part of the population. Rapid maxillary expansion (RME), a widely used procedure by orthodontists, is able to increase the volume of the upper airway in the nasal region. It is unclear in the literature if RME has effects on the reduction of OSA in adults. The objective of this systematic review was to evaluate whereas RME improves OSA. It was conducted in accordance by Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) and Cochrane Handbook for Systematic Reviews of Interventions. Electronic searches in LILACS/Bireme, Medline/PubMed, Web of Science, Cochrane Clinical Trials and Scopus were performed without restriction of language or date to assess clinical trials. Selection, data extraction, risk of bias and the quality of evidence and the strength of recommendation was performed by the authors. The search yielded 531 studies. After applying the eligibility criteria, 11 articles were fully read and two studies were selected for the qualitative systematic review. ROBINS indicated serious and no information risk of bias. GRADE system was applied on the following outcomes: apnea and hypopnea index, and oxygen desaturation index, for both outcomes, the strength of the evidence was very low, which means little confidence in the estimate. Due to heterogeneity of the data available, a meta-analysis could not be conducted. Despite the limitations of the studies included in the review, they suggested that RME improves OSA. Randomized clinical trials should be performed to assess reliable evidences.

Keywords: Obstructive sleep apnea. Palatal expansion technique. Systematic review.

LISTA DE ABREVIATURAS E SIGLAS

AOS	Apneia Obstrutiva do Sono
CCT	*Controlled Clinical Trials* / Ensaio Clínico não controlado
CPAP	*Continuous Positive Airway Pressure*
D.D.O.	Dauro Douglas Oliveira
DECS	Descritores em Ciências da Saúde
G.S.S.	Giordani Santos Silveira
GRADE	G*rading of Recommendations Assessment, Development and Evaluation*
IAH	Índice de Apneia e Hipopneia
L.G.A.	Lucas Guimarães Abreu
L.T.O.	Lívia Torquato Oliveira
MeSH	*Medical Subject Headings*
NOSE	*Nasal Obstructive Symptoms Evaluation*
OMS	Organização Mundial da Saúde
OSA	*Obstructive Sleep Apnea*
RME	*Rapid Maxillary Expansion*
PICO	*Population, Intervention, Comparison, Outcome*
RCT	*Randomized Clinical Trial* / Ensaio Clínico Randomizado
PRISMA	*Preferred Reporting Items for Systematic Reviews and Meta-Analysis*
PUC	Pontifícia Universidade Católica de Minas Gerais
RIS	*Research Information Systems*
RS	Revisão Sistemática
SAHOS	Síndrome da Apneia e Hiponeia Obstrutiva do Sono
SaO2	Saturação de Oxigênio
SARPE	*Surgically Assisted Rapid Palatal Expansion*

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1 INTRODUÇÃO

Os distúrbios do sono, tais como insônia, sonambulismo, terror noturno e apneia atingem 40% da população (Organização Mundial da Saúde, 2017). A qualidade do sono está fortemente ligada à promoção e à manutenção da saúde a curto e longo prazos. A duração e a qualidade do sono desempenham papéis importantes no risco de distúrbios metabólicos e controle do peso (ELENA et al., 2016).

A apneia obstrutiva do sono (AOS) é um distúrbio do sono cada vez mais comum na sociedade contemporânea, caracterizada pela recorrente obstrução parcial ou total das vias aéreas superiores durante o sono (KOHLER; STRADLING, 2010; PUNJABI, 2008; YOUNG; SKATRUD; PEPPARD et al., 2004). Afeta 5% da população adulta (YOUNG; PAPPARD; GOTTLIED, 2002) e é uma doença potencialmente fatal devido a sua íntima relação com o aumento da pressão arterial e risco aumentado para doenças cardiovasculares (KOHLER; STRADLING, 2010).

A obstrução parcial ou total das vias aéreas superiores pode causar episódios de apneia e hipopneia. O evento apneia é caracterizado pela cessação da passagem do ar pelas vias aéreas superiores por 10 segundos ou mais, e a hipopneia é quando há a redução do fluxo do ar, em até 50% nas vias áreas (PUNJABI, 2008; KOHLER; STRADLING, 2010).

Originalmente, a AOS foi denominada como Síndrome de Pickwickan, em 1835, devido influência de uma famosa novela escrita por Charles Dickens, a qual um personagem popular chamado Pickwick apresentava sinais e sintomas clássicos da AOS: sonolência diurna, obesidade e ronco seguido de falta de ar. A doença foi considerada um distúrbio respiratório do sono após uma conferência na Itália em 1972. E, em 1973, foi denominada como síndrome da apneia e hipopneia obstrutiva do sono (SAHOS) após reunião de diversos casos clínicos em que os pacientes apresentavam sinais e sintomas semelhantes (GUILLEMINAULT; PAREJO-GALLARDO, 2017). O ronco forte, tipicamente acompanhado de falta de ar, sonolência diurna, irritabilidade, dificuldade de concentração e cefaleias são os principais sintomas (BASTA; VGONTZAS, 2007; PUNJABI, 2008; YOUNG; SKATRUD; PEPPARD, 2004).

Os frequentes episódios de apneia e hipopneia são associados a dessaturação de oxigênio no sangue, resultando em uma hipóxia intermitente que

leva ao microdespertar noturno. A dessaturação de oxigênio durante o sono está associada ao aumento da pressão arterial e ao risco de desenvolvimento de doenças cardiovasculares (KOHLER; STRADLING, 2010). As doenças cardiovasculares são as principais causas de morte no mundo, em média 31%, de acordo com relatório de 2017 da OMS (ORGANIZAÇÃO MUNDIAL DA SAÚDE, 2017). Além disso, há outras consequências da AOS, destacando-se a sonolência diurna excessiva, disfunção cognitiva, comprometimento no desempenho do trabalho e diminuição da qualidade de vida (PUNJABI, 2008; YOUNG; PAPPARD; GOTTLIED, 2002). Portanto, a AOS trata-se de uma importante preocupação de saúde pública (YOUNG; PAPPARD; GOTTLIED, 2002).

A obesidade é o principal fator de risco relacionado à AOS (BASTA; VGONTZAS, 2007; PEPPARD et al., 2000; YOUNG; PAPPARD; GOTTLIED, 2002). Aproximadamente 70% dos pacientes com AOS são obesos e 40% dos obesos possuem a doença (PARISH; TERRENCE; FACCHIANO, 2007). Está relacionada ao uso de álcool, fumo, menopausa, presença de ovário policístico e à predisposição genética (COUGHLIN et al., 2004; YOUNG; PAPPARD; GOTTLIED, 2002; YOUNG; SKATRUD; PEPPARD et al., 2004; PUNJABI, 2008). Deve-se avaliar também a presença de congestão nasal, desvio de septo, retrognatismo maxilar e/ou mandibular, macroglossia, má oclusão dentária, tecidos linfáticos aumentados, úvula aumentada, palato mole inferiormente posicionado, e circunferência do pescoço aumentada (maior que 40 centímetros em mulheres e 43 centímetros em homens, indicam risco de AOS). Exames complementares relacionados à anemia, hipotireoidismo, diabetes, doenças do fígado, rins e exames de sangue devem ser avaliados, pois apesar de não darem o diagnóstico, agem como auxiliares (YOUNG; SKATRUD; PEPPARD et al., 2004).

O diagnóstico deve ser feito por meio dos sintomas observacionais e dos resultados da polissonografia, de acordo com o manual da Academia Americana de Medicina do Sono (AMERICAN ACADEMY OF SLEEP MEDICINE, 2018). A polissonografia é um exame não invasivo que mede a atividade respiratória, muscular e cerebral durante o sono. A classificação da doença é de leve, moderada e severa baseada no Índice de Apneia e Hipopneia (IAH) (Quadro 1), achados clínicos, índice de saturação de oxigênio e arritmias cardíacas. Pacientes com AOS severa apresentam alto índice de sonolência diurna, que interferem nas atividades

diárias, possuem risco significativamente elevado de hipertensão arterial, infarto do miocárdio, acidente vascular cerebral (AVC) e tromboembolia (BERRY, 2017).

Quadro 1 – Classificação da Apneia Obstrutiva do Sono – IAH / número de episódios por hora

IAH / hora	Classificação
5 a 15	Leve
15 a 30	Moderada
>30	Severa

Fonte: AMERICAN ACADEMY OF SLEEP MEDICINE, 2018

Outros importantes exames auxiliares de diagnóstico, principalmente, a fim de avaliar possíveis métodos de tratamento, são:

a) escala de sonolência de Epworth, capaz de medir o grau de sonolência diurno (idealmente deve apresentar valor menor ou igual a 9) (Tabela 1) (JOHNS, 1991).

Tabela 1 – Escala de sonolência de Epworth

Número mais apropriado para situação
1: Pequena chance de cochilar
2: Chance média de cochilar
3: Grande chance de cochilar

Situação	Chance de cochilar
Sentado/a e lendo	
Assistindo televisão	
Sentado/a quieto/a num local público (por ex.: no teatro, no cinema ou numa reunião)	
Como passageiro/a em um carro durante uma hora sem paradas	
Deitado/a, à tarde, para descansar, quando as circunstâncias permitem	
Sentado/a, conversando com alguém	
Sentado/a, quieto/a depois de um almoço sem bebida alcoólica	
Dentro de um carro, parado durante alguns minutos no trânsito	

Fonte: Adaptado de BERTOLAZI et al., 2009

b) escala de Avaliação dos Sintomas de Obstrução Nasal - NOSE (*Nasal Obstruction Symptom Evaluation*): um questionário específico para avaliação dos sintomas de obstrução nasal, atuando como indicador de qualidade de vida e comparação da eficácia de tratamentos clínicos e cirúrgicos da obstrução nasal. Os valores para cada item são somados entre si e multiplicados por 5, a fim de se obter um resultado graduado entre 0 e 100. Resultados entre 0-25 indicam obstrução nasal branda, 26-50 moderada e maiores que 50, sugerem obstrução nasal severa. (Tabela 2) (MENEGAT et al., 2015).

Tabela 2 – Escala de Avaliação dos Sintomas de Obstrução Nasal – NOSE

Sintoma	Não é um problema	Problema muito leve	Problema moderado	Problema considerável	Problema grave
Congestão nasal	0	1	2	3	4
Obstrução nasal	0	1	2	3	4
Dificuldade de passar o ar pelo nariz	0	1	2	3	4
Obstrução nasal ao dormir	0	1	2	3	4
Obstrução nasal aos exercícios	0	1	2	3	4

Fonte: Adaptado de ALVES et al., 2010

O tratamento da AOS é multifatorial e deve ser individualizado. A mudança de hábitos é fundamental, o emagrecimento está indicado em pacientes que apresentam obesidade, assim como a eliminação de outros fatores de risco. O tratamento convencional se dá pelo uso de um aparelho de pressão contínua positiva do ar (CPAP), que libera as vias aéreas durante o sono, porém estudos apontam elevada taxa de não aderência ao tratamento, variando de 46 a 83%. Dispositivos intraorais de avanço mandibular também podem ser utilizados, tendo eficácia apenas em casos de apneia leve a moderada. Pacientes que não aderem ao tratamento convencional e/ou não se adaptam a dispositivos acabam tendo que

recorrer a tratamentos cirúrgicos (CAMACHO; CERTAL; CAPASSO, 2013). Quanto a estes, encontram-se na literatura diversos tipos de cirurgia, dentre elas:

a) cirurgias de tecido mole: uvulopalatofaringoplastia, amigdalectomia, avanço do músculo genioglosso, glossectomia da linha média, redução da aritenóide, epiglotectomia, estimulador/implante do nervo hipoglosso, cirurgia nasal, faringoplastia lateral;
b) cirurgias em tecido duro: avanço mandibular, avanço maxilomandibular, suspensão do osso hioide, faringoplastia com avanço transpalatino, expansão rápida da maxila cirurgicamente assistida (SARPE), implantes palatais.

A traqueostomia é a última opção cirúrgica, caracterizada pela criação de um orifício na traqueia para permitir a passagem do ar diretamente para o trato respiratório por meio de uma cânula. A combinação de diversos tipos de cirurgia tem mostrado resultados eficazes, como a associação da uvulopalatofaringoplastia e avanço maxilomandibular (CAMACHO; CERTAL; CAPASSO, 2013; JOHAL; CONAGHAN, 2004; PARK; RAMAR; OLSON, 2011).

A AOS apresenta etiologia multifatorial e existe uma relação direta entre anormalidades craniofaciais e o desenvolvimento da doença quando as vias aéreas são afetadas. As anomalias craniofaciais mais frequentemente identificadas são: retrognatismo mandibular, posicionamento inferior do osso hioide em relação à mandíbula, estreitamento posterior das vias aéreas e o palato mole posicionado inferior e posteriormente (CISTULLI, 1996; RYLEY et al., 1983). Pacientes que apresentam maxilas atrésicas, comumente apresentam obstrução nasal e posicionamento mais posterior e inferior da língua na cavidade oral (ALOUFI; PRESTON; KAWAWI, 2012; OZBEK et al., 2009; SUBTLNY, 1954), achados estes positivamente relacionados ao desenvolvimento da AOS.

A maxila atrésica é caracterizada por um palato profundo, menor distância intercaninos e intermolares e pelo estreitamento da maxila em relação aos outros ossos da face, principalmente a mandíbula. A distância entre as paredes nasais é diminuída e o septo nasal é menor, o que acarreta maior resistência à passagem do ar na região, por diminuição do volume das vias áreas (ASHBY, 2001; AGOSTINO et al., 2014; HERSHEY; STEWART; WARREN, 1976). A constrição maxilar pode estar associada a outros tipos de alterações dentoesqueléticas, resultando em

implicações estéticas e funcionais, incluindo problemas respiratórios (BARALDI; PRETTO; PURICELLI, 2007; MAGNUSSON et al., 2011). A mordida cruzada posterior é o achado mais frequente em discrepâncias transversas da maxila. A prevalência de mordida cruzada posterior varia de 2,7 a 23,3% na população, sendo a constrição maxilar maior responsável por sua ocorrência (VANDERSEA; RUVO; FROST, 2007).

A fim de solucionar a discrepância transversa maxilar, em pacientes em crescimento indica-se a expansão rápida da maxila (ERM), procedimento que consiste na instalação de um aparelho ancorado nos dentes posteriores que é ativado por meio de um parafuso no sentido transverso diariamente entre 0,4 e 0,8 milímetros, promovendo a separação da sutura palatina mediana, levando a expansão maxilar (VINHA, 2016). Em pacientes que já atingiram a maturidade esquelética, ou seja, a sutura palatina está em processo avançado ou completo de fusão, um procedimento cirúrgico ou com ancoragem esquelética está indicado (ANGELIERI, 2016). No caso de procedimento cirúrgico, um expansor rápido da maxila, aparelho com um parafuso que faz a abertura no sentido transverso, é instalado e ativado após a liberação das estruturas ósseas (procedimento de Le Fort I total ou apenas pela liberação das junções pterigomaxilares) (MEDEIROS; MEDEIROS, 2013). A expansão da maxila apoiada em ancoragem esquelética consiste na instalação de um aparelho disjuntor apoiado em dentes e/ou mini implantes colocados no palato, e está indicada em adultos jovens (HOLTY; GUILLEMINAULT, 2012; MAGNUSSON et al., 2011; SUZUKI et al., 2016). Em todos os casos, o aparelho é ativado até o limite da expansão, ou seja, quando as cúspides palatinas dos molares superiores entram em contato com as cúspides vestibulares dos molares inferiores.

A ERM promove ampliação do assoalho nasal, reduzindo a resistência na passagem do ar e eventualmente corrigindo a disfunção respiratória (MITSUDA et al., 2010; RAMIRES; MAIA; BARONE, 2008). Além disso, permite que a língua se posicione mais superiormente, liberando assim as vias aéreas. Estudos demonstram melhora na respiração nasal apenas com a ampliação da cavidade nasal (BARALDI; PRETTO; PURICELLI, 2007; CISTULLI; PAMISANO; POOLE, 1998; MITSUDA et al., 2010; PIRELLI; SAPONARA; GUILLEMINAULT, 2004; RAMIRES; MAIA; BARONE, 2008). Revisões sistemáticas e estudos clínicos concluem que a ERM

possui significativo efeito benéfico na AOS e melhora do IAH em crianças (ABDULLATIF et al., 2016; JOHAL; CONAGHAN, 2004; VALE et al., 2017).

A melhora na respiração nasal por meio do ganho de dimensão transversa da maxila é fato e a AOS está relacionada a cessação ou redução da passagem do ar pelas vias aéreas. No entanto, não há clareza nos achados da literatura se a melhora da respiração nasal por meio da ERM pode afetar ou contribuir no tratamento da AOS em adultos. Com o intuito de verificar se há evidência de relação entre ERM e melhora da AOS em adultos, uma revisão sistemática (RS) foi realizada.

2 OBJETIVOS

2.1 Objetivo geral

Identificar o nível de evidência científica disponível na literatura mundial a respeito da influência da ERM na presença de AOS em pacientes adultos, por meio de uma RS.

2.2 Objetivos específicos

a) verificar se há diferença significante entre técnicas de ERM na melhora da AOS;
b) apresentar resultados das técnicas de ERM relacionados ao IAH como desfecho principal do estudo;
c) expor resultados relacionados ao índice de saturação de oxigênio, mudanças na Escala de Sonolência de Epworth e alterações na Escala de Avaliação dos Sintomas de Obstrução Nasal (NOSE), se presentes.

3 MATERIAL E MÉTODOS

3.1 Protocolo e registro

Esta RS foi elaborada a partir das diretrizes e orientações do *Preferred Reporting Items for Systematic Reviews and Meta-Analysis* (PRISMA) (MOHER et al., 2010) e Cochrane *Handbook for Systematic Reviews of Interventions* (versão 5.3) – disponível no aplicativo *Review Manager* 5.3. É desejável que a intenção de se realizar uma revisão sistemática seja documentada, por forma de um protocolo, a fim de agregar valor ao trabalho realizado e evitar realização de estudos similares.

Um protocolo para esta RS foi publicado na base *International Prospective Register of Systematic Reviews* (PROSPERO) em 31/01/2018. O título do protocolo foi "*Do palatal expansion techniques improve obstructive sleep apnea in adults? A systematic review*". O número do registro é: CRD42018087013 (ANEXO A).

3.2 Critérios de elegibilidade

Estudos clínicos randomizados (RCT) ou estudos clínicos não randomizados (CCT) com adultos maiores de 19 anos de idade poderiam ser incluídos. A fim de estabelecer maior variabilidade, estudos que comprovassem que a amostra não possuía crescimento craniofacial remanescente também poderiam ser selecionados. Para inclusão, os estudos precisavam avaliar os efeitos da ERM em adultos com AOS comparando estes indivíduos com adultos com AOS submetidos, não submetidos à ERM ou submetidos à outra intervenção ortodôntica. Estudos que avaliavam os efeitos da ERM em adultos com AOS sem um grupo de comparação também poderiam ser incluídos. Para estes últimos, pelo menos uma avaliação entre o momento antes e o momento depois da intervenção deveria ser feita.

Resumos publicados em anais de congressos, cartas ao editor, comentários e revisões da literatura foram excluídos.

O acrônimo PICO para formulação de revisões sistemáticas foi utilizado (Quadro 2) (AKOBENG, 2005; SANTOS; PIMENTA, 2007).

Quadro 2 – Diretrizes do estudo (PICO)

P – População	Adultos maiores de 19 anos ou indivíduos que não apresentam crescimento craniofacial residual com apneia obstrutiva do sono
I – Intervenção	Expansão Rápida da Maxila
C – Comparação	Grupo controle (sem intervenção) ou submetido à outra intervenção. Ausência de grupo controle para comparação
O – *Outcome* – Desfechos	Alteração no índice de apneia e hipopneia, índice de saturação de oxigênio, escala de Epworth e sintomas de obstrução nasal
Pergunta estruturada	A expansão rápida da maxila melhora a apneia obstrutiva do sono em adultos?

Fonte: Elaborado pela autora

3.3 Fontes de informação

A pesquisa bibliográfica inicial foi realizada na data de 21/01/2018 na Universidade Federal de Minas Gerais, nas seguintes bases de dados: LILACS/Bireme, MEDline via PubMed, Web of Science, Cochrane Clinical Trials e Scopus. Não foi imposta nenhuma restrição de idioma ou data de publicação. Durante toda a execução do trabalho as revistas *The Angle Orthodontist, American Journal of Orthodontics* e *Sleep Medicine* foram monitoradas de 2016 até o momento, em caráter complementar de busca manual de estudos.

As bases de dados supracitadas, Google Scholar e US Clinical Trials serão pesquisadas próximo a data de submissão do artigo, com a utilização de estratégia de busca similar, a fim de agregar possíveis novos estudos publicados.

3.4 Estratégias de busca

O processo de identificação dos estudos foi executado na presença de três autores, sob orientação do mais experiente em buscas bibliográficas (L.G.A.). Palavras chaves, termos indexados, expressões e as suas possíveis combinações

obtidas através de um mapeamento conceitual foram utilizadas a fim de englobar o maior número de trabalhos relacionados com os objetivos propostos para este estudo. As estratégias de busca foram definidas (Quadro 3) e adaptadas para cada base de dados e suas respectivas normas na busca avançada (ANEXO B).

Quadro 3 – Estratégias de busca

Termo DECS	TERMO *MeSH*	Estratégia de busca
Apneia Obstrutiva do Sono	*Obstructive Sleep Apnea*	*Obstructive Sleep Apnea OR Obstructive Sleep Apneas OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Obstructive Syndrome Sleep Apnea OR Obstructive Sleep Apnea Syndrome OR Apnea OR Sleep Apnea Hypopnea Syndrome OR Obstructive Sleep Apnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR Sleep Apnea Syndrome Upper Airway Resistance OR sleep apnea OR obstructive sleep apnea and hypopnea syndrome OR OSA OR sleep disorder*
Técnica de Expansão Palatina	*Palatal Expansion Technique*	*Palatal Expansion Technique OR Palatal Expansion Techniques OR Palatal Expansion Techniques OR Palatal Expansion Technic OR Palatal Expansion Technics OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR distraction osteogenesis maxillary expansion OR surgically assisted rapid maxillary expansion OR SARPE OR maxillary skeletal expander OR MSE OR microimplant-assisted rapid palatal expander OR mini-implant assisted rapid palatal expansion OR mini-screw assisted rapid palatal expansion OR MARPE OR microimplant-assisted rapid maxillary expander OR mini-implant assisted rapid maxillary expansion OR mini-screw assisted rapid maxillary expansion OR MARME OR implant-supported rapid maxillary expansion OR mini-implant anchorage on bone-borne palatal expansion OR bone-borne palatal expansion*

Fonte: Elaborado pela autora

Os resultados das pesquisas foram agrupados e arquivados em conta pessoal do aplicativo *EndNote* online, no qual, artigos repetidos foram eliminados, gerando um arquivo *Reserach Information Systems* (RIS) contendo título, referência e resumo dos artigos encontrados que foram exportados para o programa *EndNote* para desktop. Este programa converteu o arquivo RIS em um arquivo Word, que foi impresso para leitura e seleção dos estudos. O arquivo foi lido de forma independente por dois autores (L.T.O e G.S.S) e os estudos que apresentaram

características compatíveis ao desenho do estudo foram selecionados para leitura íntegra do texto. No início da leitura, a fim de estabelecer um padrão na seleção de estudos, reuniões para discutir os critérios de elegibilidade (Quadro 4) foram realizadas, assim como uma análise estatística (teste Kappa) de concordância foi realizada diante da leitura dos primeiros sessenta títulos e resumos.

Quadro 4 – Critérios de inclusão e exclusão

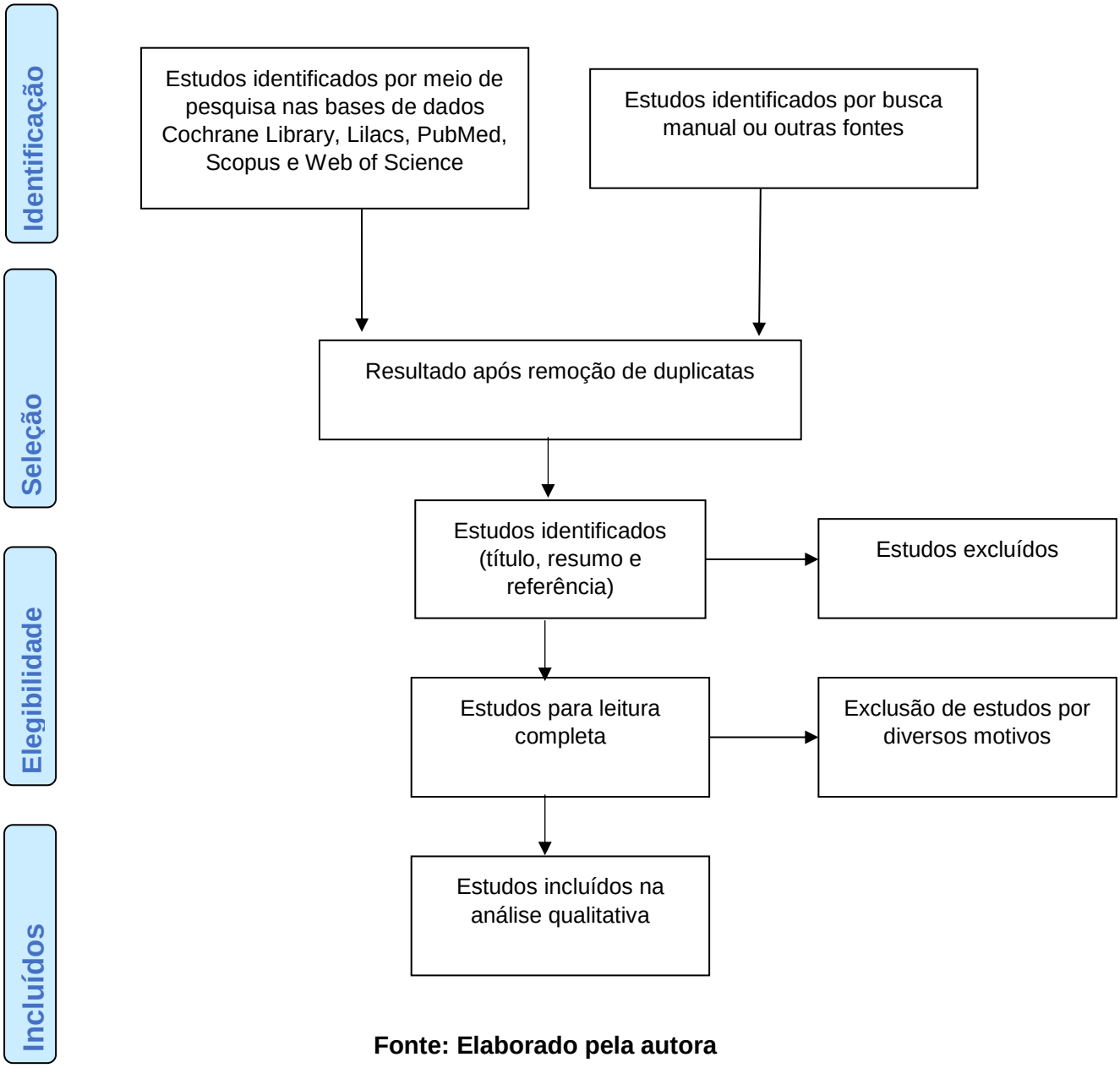
Critérios de inclusão	Critérios de exclusão
Adultos maiores de 19 anos ou indivíduos que cessaram o crescimento craniofacial e possuam atresia maxilar	Indivíduos não portadores de apneia obstrutiva do sono
Diferentes técnicas de expansão palatina	Indivíduos que realizaram cirurgias conjugadas ou utilizaram outros métodos de tratamento
Comparar índice de apneia e hipopneia, índice de saturação de oxigênio, escala de Epworth e sintomas de obstrução nasal após uso de alguma técnica de expansão palatina	Não ter dados pré e pós intervenção bem descritos relacionados à apneia obstrutiva do sono

Fonte: Elaborado pela autora

O teste Kappa é uma medida de concordância interobservador e mede o grau de concordância além do que seria esperado tão somente pelo acaso. Esta medida de concordância tem como valor máximo 1, representando total concordância, valores próximos e até abaixo de 0, indicam nenhuma concordância. Divergências foram discutidas pelos autores e expostas a um terceiro autor, a fim de se obter um consenso a partir das opiniões divergentes. Caso houvesse estudos selecionados que não possuíssem texto na íntegra, os autores seriam contatados via correio eletrônico.

3.5 Análise dos estudos

Fluxograma 1 – Diagrama PRISMA



Fonte: Elaborado pela autora

Dentre os artigos incluídos na RS, a extração dos dados foi realizada para a análise do risco de viés e qualidade dos resultados.

3.5.1 Análise de ensaios clínicos randomizados

A análise do risco de viés para ensaios clínicos randomizados, se presentes, seria realizada por meio da ferramenta COCHRANE disponível para uso no aplicativo Review Manager 5.3. A ferramenta avalia sete domínios:

a) geração da sequência aleatória;
b) ocultação da alocação;
c) cegamento de participantes e profissionais;
d) cegamento de avaliadores de desfecho;
e) desfechos incompletos;
f) relato seletivo de caso;
g) outras fontes de vieses.

Dois revisores (L.T.O e G.S.S) avaliariam, de maneira independente, o risco de viés em cada estudo selecionado, que recebe uma das classificações: baixo risco de viés, risco de viés incerto ou alto risco de viés. O aplicativo gera um gráfico ilustrativo (Gráfico 1).

Gráfico 1 – Modelo de gráfico da análise do risco de viés de RCT's

Fonte: Elaborado pela autora

3.5.2 Análise de ensaios clínicos não randomizados

A análise do risco de viés para ensaios clínicos controlados não randomizados, se presentes, seria realizada por meio da ferramenta ROBINS (STERNE et al., 2016), indicação da Cochrane para avaliação destes tipos de estudos. A ferramenta avalia vieses envolvidos em sete domínios:

a) confusão;
b) seleção dos participantes para o estudo;
c) classificação das intervenções;
d) desvio das intervenções pretendidas;
e) ausência de dados;
f) medição dos desfechos;
g) relato seletivo de caso.

Dois revisores (L.T.O e G.S.S) avaliariam, de maneira independente, o risco de viés em cada estudo selecionado, que recebe uma das classificações: baixo, moderado, sério, crítico e sem informação (Quadro 5). Reuniões para discutir o uso da ferramenta e resultados obtidos foram executadas na presença do pesquisador mais experiente (L.G.A.).

Quadro 5 – Critérios para estabelecer o risco de viés de CCT's

Baixo	O estudo apresenta baixo risco de viés se todos os domínios foram classificados com baixo risco de viés
Moderado	Todos os domínios foram classificados com baixo ou moderado risco de viés
Sério	Pelo menos um domínio foi julgado como sério e nenhum com risco crítico de viés.
Crítico	Um ou mais domínios foram julgados com risco crítico de viés
Sem informação	As informações não são claras para indicar se o estudo está em risco sério ou crítico de viés. Há falta de informação em um ou mais domínios.

Fonte: Adaptado de STERNE et al., 2016

3.5.3 Análise da qualidade e força de recomendação dos estudos

A análise da qualidade dos resultados e força de recomendação foi realizada por meio da ferramenta GRADE (Grading of Recommendations Assessment, Development and Evaluation) (BALSHEM et al., 2011; BRASIL, 2014). A ferramenta avalia cada um dos desfechos de forma independente. Foi desenvolvida por um grupo colaborativo de pesquisadores que visaram à criação de um sistema universal, transparente e sensível para graduar a qualidade das evidências e a força das recomendações. A qualidade da evidência e força de recomendação é classificada em quatro níveis:

Quadro 6 - Avaliação da qualidade da evidência

Nível	Definição	Implicações	Fonte de informação
Alto	Há forte confiança de que o verdadeiro efeito esteja próximo daquele estimado	É improvável que trabalhos adicionais irão modificar a confiança na estimativa do efeito	- Ensaios clínicos bem delineados, com amostra representativa. - Em alguns casos, estudos observacionais bem delineados, com achados consistentes*
Moderado	Há confiança moderada no efeito estimado	Trabalhos futuros provavelmente poderão modificar a confiança na estimativa de efeito, podendo, inclusive, modificar a estimativa	- Ensaios clínicos com limitações leves** - Estudos observacionais bem delineados, com achados consistentes*
Baixo	A confiança no efeito é limitada	Trabalhos futuros provavelmente terão um impacto importante em nossa confiança na estimativa do efeito	- Ensaios clínicos com limitações moderadas** - Estudos observacionais comparativos: coorte e caso-controle.
Muito baixo	A confiança na estimativa do efeito é muito limitada. Há importante grau de incerteza nos achados	Qualquer estimativa de efeito é incerta	- Ensaios clínicos com limitações graves** - Estudos observacionais comparativos com presença de limitações** - Estudos observacionais não comparados*** - Opinião de especialistas

*Estudos de coorte sem limitações metodológicas, com achados consistentes apresentando tamanho de efeito grande e/ou gradiente dose resposta.
**Limitações: vieses no delineamento do estudo, inconsistência nos resultados, desfechos substitutos ou validade externa comprometida.
***Séries e relatos de casos

Fonte: BRASIL, 2014

Para cada resultado avaliado, o GRADE avalia o número de estudos incluídos, o desenho dos estudos, o risco de viés, inconsistência, evidência indireta, imprecisão e outras considerações (viés de publicação). De acordo com a gravidade da limitação, a evidência pode ser rebaixada em um ou dois níveis, numa pontuação que vai de 1 a 9.

Quadro 7 - Fatores que reduzem ou elevam a qualidade da evidência

Fator que reduz a qualidade	Consequência
Limitações metodológicas (rico de viés)	↓ 1 ou 2 níveis
Inconsistência	↓ 1 ou 2 níveis
Evidência indireta	↓ 1 ou 2 níveis
Imprecisão	↓ 1 ou 2 níveis
Viés de publicação	↓ 1 ou 2 níveis
Fator que aumenta a qualidade	Consequência
Elevada magnitude de efeito	↑ 1 ou 2 níveis
Fatores de confusão residuais que aumentam a confiança de estimativa	↑ 1 nível
Gradiente dose-resposta	↑ 1 nível

Fonte: BRASIL, 2014

A avaliação da qualidade pode auxiliar no processo de recomendação da intervenção, a ponto que estudos que podem apresentar limitações metodológicas são mais propensos a vieses, porém, não indicam a qualidade da evidência. A análise foi realizada pelo autor mais experiente e discutida entre todos.

4 ARTIGO

Does rapid maxillary expansion improve obstructive sleep apnea in adults? A systematic review

Artigo preparado dentro das normas do periódico **Sleep and Breathing** (*Qualis*: A2).

Normas para submissão de artigos podem ser visualizadas no endereço eletrônico: https://link.springer.com/journal/11325

Does rapid maxillary expansion improve obstructive sleep apnea in adults? A systematic review

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ABSTRACT

Objectives: To evaluate the effects of rapid maxillary expansion in adults with obstructive sleep apnea.

Material and Methods: Electronic searches in Cochrane Clinical Trials, LILACS/ Bireme, Medline Ovid, PubMed, Scopus, U.S. Clinical Trials, and Web of Science were conducted in January 2018 and updated in January 2019. Manual searches in the reference list of the included studies and a gray literature search using Goggle Scholar were also performed. No restriction on language or date of publication was imposed. Study selection, data extraction, and risk of bias evaluation using ROBINS-I were performed by two reviewers independently. Quality of evidence and the strength of recommendation assessment using the GRADE system was also carried out.

Results: The electronic searches yielded 531 studies. After the removal of 222 duplicates, 309 references were screened. Following the application of the eligibility criteria, eleven articles were fully read and two studies were included in this systematic review. The included studies showed that the Apnea-Hypopnea Index and the Epworth Sleepiness Scale improved after rapid maxillary expansion in adults. One included study demonstrated that the oxygen desaturation index also improved after rapid maxillary expansion. ROBINS-I indicated a serious risk of bias in one included study and no information regarding risk of bias in the other. The GRADE system was applied to the following outcomes: apnea and hypopnea index and oxygen desaturation index. For both outcomes, the reliability of the evidence was very low. Due to heterogeneity of the available data, a meta-analysis was unfeasible.

Conclusion: Rapid maxillary expansion improves obstructive sleep apnea in adults.

KEY WORDS: Obstructive sleep apnea; Palatal expansion technique; Systematic review

INTRODUCTION

Obstructive Sleep Apnea (OSA) is a disorder that has become ever-increasingly common in contemporary society, characterized by the partial or total obstruction of the upper airways while the individual is sleeping.[1–3] OSA is associated with high blood pressure and the risk of developing cardiovascular diseases,[3] which can lead to death. OSA also generates other consequences that can negatively affect an individual's quality of life, such as excessive sleepiness, cognitive dysfunction, and the loss of efficiency in professional activities.[2, 4]

Among the various risk factors associated with OSA, what stand out are obesity, smoking, alcohol use, nasal congestion, nasal septum deviation, macroglossia, increased lymphatic tissues, positioning below the soft palate, maxillary and/or mandibular retrognathism, and maxillary atresia.[1, 2, 4–6] There is a direct relationship between the development of this disorder and the presence of craniofacial anomalies that affect the airways.[7, 8] Individuals that present maxillary atresia commonly present nasal obstruction, together with the positioning of the tongue below and behind the oral cavity.[9, 10] In addition, the distance between the nasal walls, as well as the nasal septum, appears diminished, which entails greater resistance to the passage of air in this region due to the reduced volume of the airways.[11, 12]

Rapid maxillary expansion (RME), associated or not with mini-implants (Mini-implant assisted rapid palatal expansion - MARPE) and/or Le Fort I surgery (Surgically Assisted Rapid Palatal Expansion - SARPE), is a procedure used to correct transverse discrepancy in order to correct malocclusion in adults.[13–15] As it is an orthopedic procedure to separate the two hemi maxilla it also promotes the expansion of the nasal cavity by distancing its side walls, thus reducing the resistance in the passage of air and correcting a nasal respiratory disorder.[11, 16–20] In addition, it allows for a positioning above the tongue, due to the widening of the dental arch, contributing to the opening of the airways.[21]

Some studies have reported that RME has a significant beneficial effect in children with OSA.[22–24] By contrast, scientific evidence regarding the effects of this procedure in adults with OSA is still nuclear. Therefore, the aim of this systematic review was to evaluate the effects of RME in adult individuals with OSA.

MATERIALS AND METHODS

Protocol and registration

This systematic review was registered in the database, International Prospective Register of Systematic Reviews (PROSPERO) (https://www.crd.york.ac.uk/prospero/) under registration number CRD42018087013. The article has been written following Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. [25]

Eligibility criteria

Studies that, through polysomnography, evaluated the effect of RME in adult individuals with OSA were included in this systematic review. The PICO acronym was used as follows:

(P) *Population*: adults over 19 years of age with OSA.

(I) *Intervention*: RME.

(C) *Comparison*: other modalities of intervention or absence of intervention.

(O) *Outcomes*: Apnea-Hypopnea Index (AHI), Oxygen Desaturation Index (ODI), Epworth Sleepiness Scale (ESS), and Nose Obstruction Symptom Evaluation (NOSE).

The exclusion criteria applied in this study were: studies evaluating individuals with cleft lip and palate, individuals with genetic syndromes with craniofacial manifestations, and studies evaluating individuals with a medical history of orthognathic and/or otolaryngological surgery. Congress abstracts and clinical case reports or case series were also excluded.

Search strategy

An initial electronic search was carried out in January 2018 and updated in January 2019 in the following databases: Cochrane Clinical Trials, LILACS/ Bireme, Medline Ovid, PubMed, Scopus, U.S. Clinical Trials, and Web of Science. Neither data nor publication language were restricted. The terms (MeSH or not) related to OSA and RME techniques were connected by Boolean operators (*OR, AND*), resulting in a search strategy for Pubmed. This strategy was adapted for use in the other databases (Supplementary File 1). Manual searches in the bibliographic references of the articles included in this study were also performed. Finally, a search in Google Scholar, limited to the first 300 citations, was carried out.[26] The results were imported to the EndNote Web software (Clarivate Analytics, Pennsylvania, USA), and duplicates were removed. After the duplicates had been excluded, a file with all of the references (titles/abstracts) was generated.

Study selection

Titles/abstracts were read independently by two researchers (LTO and GSS) who applied the eligibility criteria. The full texts of the titles/abstracts with insufficient information to decide on inclusion or exclusion were also read independently by the two researchers (LTO and GSS). The references that met the eligibility criteria were included in this systematic review. If a disagreement arose between the two researchers, a third was then consulted (LGA). The Kappa test was performed to evaluate the inter-researcher agreement.

Data extraction

Two researchers (LTO and GSS) extracted the data from the included articles. The following data were extracted: authors, year of publication, number of participants, characteristics of the samples (sex and participants' age), type of therapeutic modality used

for RME, evaluated outcomes, average values, and standard deviation for the outcomes before and after intervention, statistical difference (p value) between the values before and after intervention, and the follow-up period. Disagreements between the two participants were also resolved with the aid of a third researcher (LGA).

Risk of bias in individual studies

The risk analysis for bias was performed using the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool, recommended by the Cochrane collaboration for risk of bias in non-randomized clinical studies.[27] With the adoption of this tool, the risk of bias was evaluated through the seven different domains (confounding factors, selection of participants for the study, classification of interventions, deviations from intended intervention, missing data, measurement of outcomes, and selective reporting of results). For each domain, the study can be classified through a study of low, moderate, serious, or critical risk of bias. The option "no information" is also possible. The criteria for evaluation using ROBINS-I are presented in Table 1. Two reviewers (LTO and GSS) conducted the analysis independently, and the results were compared until a consensus had been reached.

Quality of evidence and strength of recommendations

The quality of evidence and the strength of recommendations was assessed by means of the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system. [28] For each evaluated outcome, the GRADE system assesses the number of studies included, study designs, risk of bias, inconsistency, indirectness, imprecision, among other considerations (such as publication bias). For risk of bias, inconsistency, indirectness, imprecision, among other considerations (such as publication bias), depending on the seriousness of the limitation, the evidence could be downgraded one or two levels. Based on

this assessment, the certainty of the evaluation of the outcome could be: very low, low, moderate, or high.

Synthesis of results

The methodological heterogeneity, coupled with the absence of a group for comparison, in the studies included in this review made it impossible to conduct a meta-analysis.

RESULTS

Study selection

The electronic searches identified 531 references, of which 222 were removed, as they were duplicates. Of the total of 309 titles/abstracts read, eleven were chosen to read the full text. During the reading of the titles/abstracts, the Kappa test showed that the inter-researcher agreement was of 0.96. After the application of the eligibility criteria in the eleven full texts, two studies were included in this systematic review. The list of the nine studies excluded after having read the complete texts and the reasons for their exclusion are shown in Supplementary File 2. The article selection process is outlined in Figure 1.

Characteristics of the included studies

The two chosen studies were non-randomized studies. The first (Vinha, 2016)[29] used the RME technique of Surgically Assisted Rapid Maxillary Expansion (SARME). This modality included the installation of the Hyrax device and the Le Fort I surgery with the separation of the pterygoid joints, the separation of the pterygoid and sphenoid bones, and osteotomy between the maxillary central incisors. The individuals of the study were chosen at the University of São Paulo, between August 2011 and February 2014, and complained of

occlusal problems, snoring, and sleepiness. Individuals with transverse deficiency of the maxilla and/or crossbite and diagnosis of OSA were screened. Of the 16 participants, seven were women and nine were men. The average age of the participants was 40.4 years. The second study included in this review (Liu, 2017)[30] used the RME technique of Distraction Osteogenesis Maxillary Expansion (DOME). Such a technique consists of the installation of an expander appliance, supported by mini-implants in the palate, as well as Le Fort I surgery, incision between the maxillary incisors, and the use of the piezocision in the midpalatal suture. The individuals were chosen between September 2014 and April 2016, and showed an intolerance to the use of CPAP (Continuous Positive Airway Pressure) or the mandibular intraoral repositioner appliance, maxillary constriction, and Mallampati classification 3 or 4. In this article, the report of the location of the study was unclear. Both studies performed polysomnography before and after intervention to diagnose OSA and controlled the confusion factor of obesity through the Body Mass Index (BMI) variable.

According to the Manual from the American Academy of Sleep Medicine, the diagnosis of OSA is performed by analyzing the symptoms and the results from polysomnography. Based on the AHI, clinical findings, ODI, and cardiac arrhythmias, the classification of the disease can be mild, moderate, or severe.[31] The AHI, as well as the ODI and the ESS, was evaluated in both studies. The study conducted by Liu et al. (2017)[30] also evaluated the NOSE.

Results of included studies

AHI

Vinha (2016)[29] demonstrated a significant reduction in AHI (p=0.001). Before the SARME, the average of AHI was 33.2 (±39.5), while after intervention, the average was 14.5

(±19.4). Liu (2017)[30] also reported a significant reduction in AHI (p<0.01). Before the DOME, the average of AHI was 30.9 (±27.1). After intervention, the average was 14.2 (±9.3).

ODI

Vinha et al. (2016)[29] showed a significant reduction in ODI (p=0.047). The ODI value before intervention was 21.3(±31.6), while after SARME it was 14.8(±25.9). Findings from Liu (2017)[30] demonstrated that this reduction was not significant (p=0.07): 23(±28.4) before intervention to 8.7(±6.9) after intervention.

Epworth Sleepiness Scale

Findings from Vinha et al. (2016)[29] (p<0.001) and Liu (2017)[30] (p<0.001) showed a significant reduction in ESS after intervention as compared to the moment before intervention. Table 2 shows the complete information from the characteristics and results of the studies included in this review.

Risk of bias in individual studies

In findings from Vinha (2016)[29], the risk of bias was classified as serious, as it presented problems in confounding domains and the selection of participants for the study. In Liu (2017)[30], the risk of bias was classified as “no information”, the selective reporting of results domain did not present sufficient information to draw a conclusion if there was in fact a selective report of the results published in the study. Table 3 shows the results of the evaluation of the risk of bias of the included studies, using the ROBINS-I tool. O Supplementary File 3 shows details of how this evaluation was performed.

Quality of evidence and strength of recommendations

The GRADE system was applied to the following outcomes: AHI and ODI. For the AHI outcome, there were serious concerns regarding risk of bias and indirectness, as well as very serious concerns regarding inconsistency and imprecision. Publication bias was strongly suspected. For the ODI outcome, there were serious concerns regarding risk of bias and very serious concerns regarding inconsistency, indirectness, and imprecision. Publication bias was also strongly suspected. For both outcomes, the certainty of the evidence was very low, which implies a low level of confidence in the estimate (Table 4).

DISCUSSION

Studies that have evaluated the effects of RME in young individuals with OSA have shown satisfactory results in parameters related to disease.[16, 22–24, 30, 32, 33] The results found in this systematic review sustain what has been reported in other studies conducted with children and teenagers. A significant reduction in the AHI value after the RME in adults was observed in the two studies included in this review. OSA is a multifactorial disease,[7, 8] and its treatment involves the control of diverse factors. The literature has recognized obesity as a key risk factor for the development of this disease.[4, 6, 34] Therefore, the control of the obesity variable is essential in studies that evaluate spot interventions in the prognosis of OSA. The studies included in this systematic review illustrated minimal and irrelevant changes in BMI for the observed times, thus excluding this variable as a possible confounding factor.

RME can produce favorable repercussion for nasal respiration due to the increase in the volume of the airways.[16–20] Liu (2017)[30] performed Cone Beam Computed Tomography (CBCT) exams before and after DOME intervention, showing significant differences in the anterior and posterior width of the nasal floor after intervention. However,

outcomes that can be evaluated by CBCT exams, such as volumetric or three-dimensional changes in the airways, were not investigated in the present study.

The increase in the width of the maxillary arch, resulting from the RME techniques, can lead to a positioning that is more anterior and above the tongue, promoting the opening of the oropharyngeal space[35, 36] for the passage of air, facilitating nasal respiration. The evaluation of the position of the tongue in the CBCT exam can be performed; however, influences of breathing and swallowing make it difficult to interpret the exams.[37–39] The studies included in this systematic review did not evaluate the positioning of the tongue in the oral cavity at any of the observed times. Pavoni et al. (2017)[21] suggests two-dimensional imaging to evaluate the position of the tongue. According to Occasi et al. (2017),[40] one valid and consistent protocol is necessary to evaluate the position of the tongue in CBCT exams. This may have a direct influence of the positioning of the tongue on the obstruction of airways during sleep, when the entire muscular structure is relaxed. In this sense, the adequate space created for the expansion of the oral cavity by widening the maxillary arch using the RME technique can imply a better positioning of the tongue, thereby improving one's breathing.

One useful tool in the evaluation of nasal obstruction is NOSE, a specific questionnaire to evaluate the symptoms of nasal obstruction, which acts as a quality of life indicator and as a comparison of the efficiency of the clinical and surgical treatments of nasal obstruction.[41] Menegat et al. (2015)[42] used the evaluation before applying the SARPE procedure and six months thereafter. For the participants of this study, the levels of nasal obstruction were reduced and, consequently, breathing was facilitated. Liu (2017)[30] applied the questionnaire before and after intervention. A statistically significant reduction was observed in the values, demonstrating the efficiency of the treatment of nasal obstruction.

ESS has been used in the diagnosis of OSA and as a parameter for the evaluation of the efficiency of treatment for this disease. Such a tool is capable of diagnosing excessive sleepiness, which interferes in professional activities, family relations, and social relationships. Sleepiness is capable of reducing one's cognitive performance, thus increasing the risk of accidents at work and in traffic.[43] Both studies presented significantly reduced values of results on the scale. The instrument is valid and reliable, and its improved results after RME reveal the positive impact of this procedure on the quality of life of adult individuals.

The studies included in this systematic review used surgical procedures to promote the rupture and separation of the midpalatal suture, followed by the activation of the Hyrax palatal expansion appliance or an expander supported by mini-implants to promote RME. The surgical procedure, accompanied by the activation of the expansion appliance, or SARPE, is well-documented in the literature.[13–15] By contrast, the procedure described as DOME, or surgery coupled with the activation of the expander supported by mini-implants, was a variation developed by researchers from the Stanford University in order to minimize maxillary osteotomies.[30] The recommendation of surgery or an expansion appliance supported by skeletal anchorage is necessary when the ossification of the midpalatal suture is in an advanced state or complete. Nevertheless, CBCT exams should be performed to reach a more accurate evaluation.[44, 45] A wide range of studies suggest distinct ages when recommending surgical procedures of maxillary expansion; however, there is not consensus in the literature regarding at which age this procedure should be recommended.[46–53]

The recommendation of RME techniques, especially in adults, occurs when there is a transverse discrepancy, which, many times, but not necessarily, is accompanied by a crossbite. In both studies, the characteristics of the samples was described superficially, making it unclear if the sagittal relation of the maxilla and the mandible of the participants

and if the recommendation of the RME was merely due to the transverse problem of the maxilla. In Liu (2017)[30], there was no mention of the information relative to the time of follow-up of the participants from the study after RME.

Polysomnography, together with the observance of symptoms, is a gold standard exam for the diagnosis of OSA. The American Academy of Sleep Medicine has a manual geared toward the diagnosis of PSA, and the exam should be based on the guidelines from this document. The position of the patient during sleep and the stage of sleep are important for the correct diagnosis of the disease, given that only findings from Vinha (2016)[29] reported and exposed results based on this manual.

Due to the heterogeneity between the two studies included in this review, a meta-analysis can be made. Coupled with the absence of meta-analysis, the limitations of the present systematic review were the low quality of studies included and the absence of a control group or randomized samples in these studies.

Orthodontists often recommend procedures without evaluating the systemic situation of the patients. A detailed evaluation of the anatomical structures of the upper airways and an adequate medical evaluation of the patients who receive a recommendation to undergo the RME technique is important due to its correlation with diseases, such as OSA. Since the etiology of the OSA can be related to the reduction in the volume of the upper airways and the positioning of the tongue, the RME technique appears to be a procedure that contributes to the improvement of parameters related to OSA in adult individuals. Nonetheless, conducting randomized clinical trials is still warranted in order to determine the effects of RME with greater precision in adult individuals who present OSA. Figure 2 presents the suggestion of an ideal study design to evaluate the impact of RME on OSA in adults.

CONCLUSIONS

Despite the limitations related to the studies included in this systematic review, the findings herein suggest that RME improves OSA in adults, confirmed by means of positive changes in AHI and ESS.

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FIGURE 1 –PRISMA Diagram

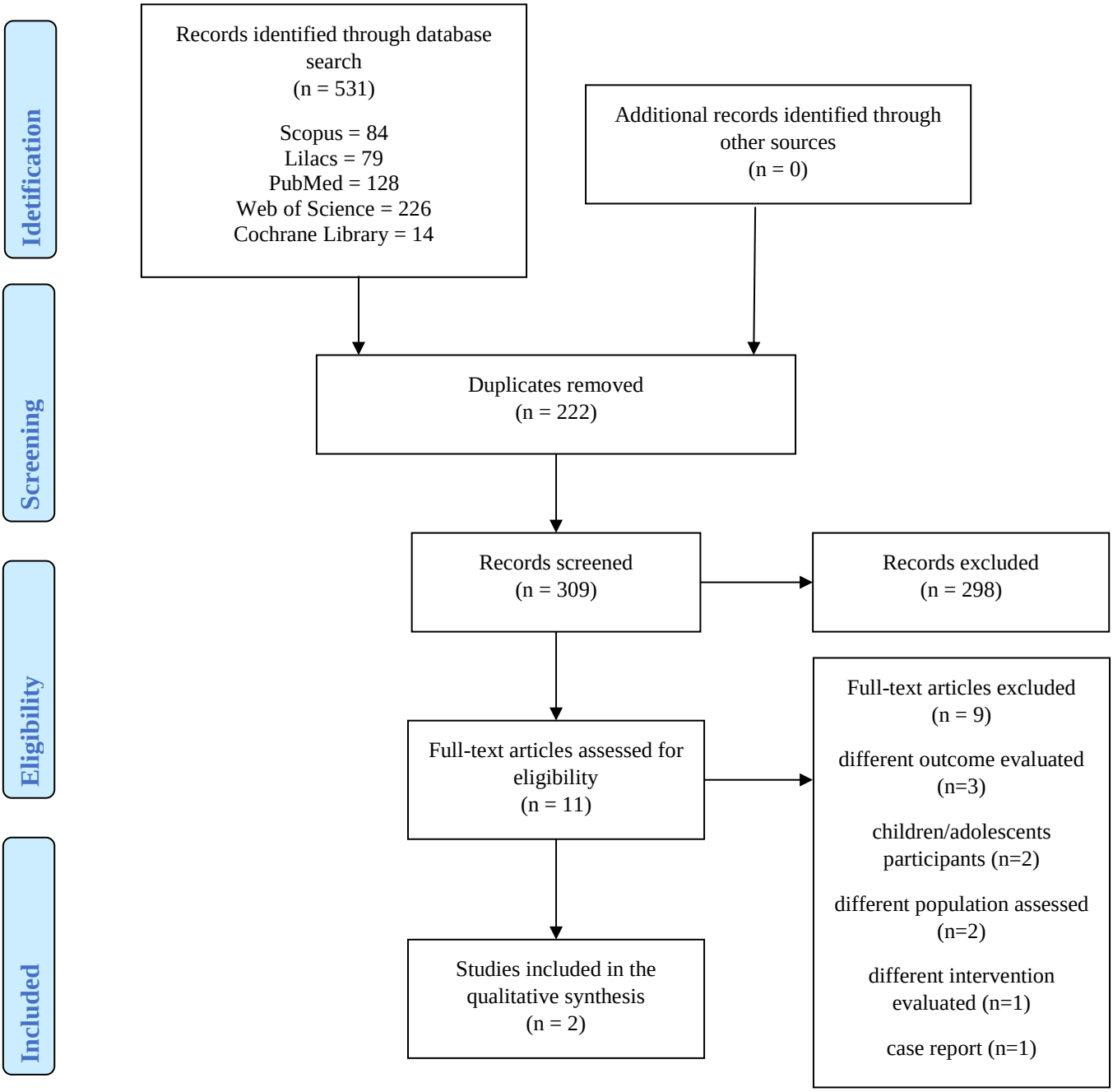
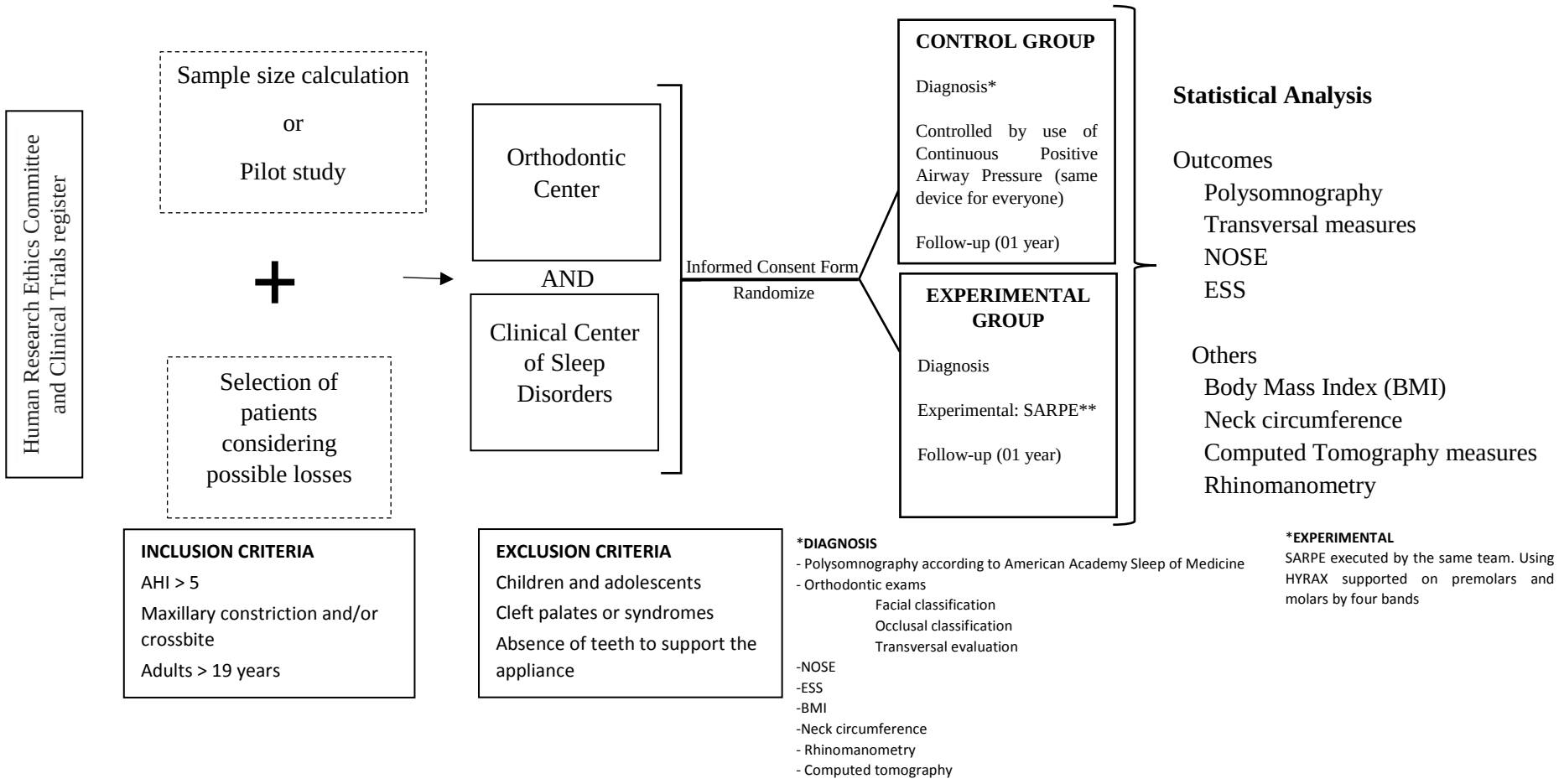


FIGURE 2 - The design of a randomized clinical trial for the evaluation of the effects of rapid maxillary expansion among adult individuals



NOSE: Nasal Obstructive Symptons Evaluation
ESS: Epworth Sleepiness Scale
BMI: Body Mass Index

TABLE 1 - Judgment for each domain and overall judgment using ROBINS-I

JUDGMENT FOR EACH DOMAIN	
Low RoB	Study is comparable to a well-performed, randomized trial with regard to this domain
Moderate Rob	Study is sound for a nonrandomized study with regard to this domain but cannot be considered comparable to a well-performed, randomized trial
Serious Rob	Study has some important problems in this domain
Critical Rob	Study is too problematic in this domain to provide any useful evidence on the effects of intervention
No information	No information on which to base a judgment about risk of bias for this domain
OVERALL JUDGMENT	
Low RoB	Study is judged to be at low risk of bias for all domains
Moderate Rob	Study is judged to be at low or moderate risk of bias for all domains
Serious Rob	Study is judged to be at serious risk of bias in at least one domain but not at critical risk of bias in any domain
Critical Rob	Study is judged to be at critical risk of bias in at least one domain
No information	No clear indication that the study is at serious or critical risk of bias, and there is a lack of information in one or more key domains of bias (a judgment is required for this)

TABLE 2 - Characteristics and results of the included studies

Study	Sample	Results				Follow-up
		Outcomes	**Pre**	**Post**	**P-value**	
		AHI	33.2±39.5	14.5±19.4	0.001	
		ODI	21.3±31.6	14.8±25.9	0.047	
		ESS	12.5±5.3	7.2±3.5	<0.001	
		Others				
		BMI	29.8±4.4	29.9±5.3	0.667	
		TST- minutes	363.1±50.03	336.9±101.1	0.519	
		Sleep efficiency %	82.0±11.58	86.6±8.1	0.216	
	N=16	REM - % TST	20.1±9.9	17.0±6.9	0.252	
	7♀/9♂	Supine - %TST	44.4±26.2	42.5±39.8	0.413	
	40.2±10.2	Apnea index	15.5±34.7	5.5±12.1	0.107	355±158
Vinha, 2016	years	Hipopnea index	18.2±22.7	9.1±10.9	0.005	days
	Intervention:	NREM AHI	28.1±30.4	10.8±21.3	0.008	
	SARME	REM AHI	29.1±39.3	17.1±19.6	0.013	
		RERAI	2.2±4.0	1.5±2.1	0.939	
		RDI	35.4±38.5	16.0±19.7	0.001	
		PLM	4.4±6.3	4.1±8.2	0.343	
		Neck – cm	40.8±3.3	40.5±3.4	0.415	
		Waist – cm	103.8±11.2	105.5±11.4	0.235	
		Distance first premolar	34.2±4.1	39.6±3.7	0.001	
		Distance molar	42.5±4.4	48.0±4.6	0.001	
		Outcomes				
		AHI	30.9±27.1	14.2±9.3	<0.01	
		ODI	23.0±28.4	8.7±6.9	0.07	
		ESS	12.3±4.1	7.8±4.8	<0.001	
	N=20;	NOSE	11.7±5.3	3.85±3.23	<0.001	
	4♀/16♂	**Others**				
Liu, 2017	31.7 ±6.5	BMI	26.8±5.0	26.4±5.5	0.44	-
	years	Reff Insp (left)	1.4±0.4	1.0±0.5	<0.001	
	Intervention:	Reff Insp (right)	1.4±0.4	0.9±0.3	<0.001	
	DOME	Nasal floor width – anterior, mm	22.7±4.58	27.4±4.7	<0.001	
		Nasal floor width – posterior, mm	27.9±4.3	32.1±4.8	<0.001	

*P<0.05 is significant
N: size of sample
♀: female
♂: male
DOME: Distraction Osteogenesis Maxillary Expansion
AHI: Apnea and Hipopnea Index
ODI: Oxygen Desaturation Index
BMI: Body Mass Index
ESS: Epworth Sleepiness Scale
NOSE: Nose Obstruction Symptom Evaluation
Reff ins: effective resistance inspiration
SARME: Surgically Assisted Rapid Maxillary Expansion
TST: Total Sleep Time
RERAI: number of arousals relative to respiratory effort
RDI: Respiratory Disturbance Index
PLM: Periodic Limb Movement

TABLE 3 - Evaluation of risk of bias of the included studies using ROBINS-I

	Domain							**Overall risk of bias judgment**
	Preintervention		At intervention	Postintervention				
	Confounding	Selecting participants for the study	Classifying the interventions	Deviations from intended intervention	Missing data	Measuring outcomes	Selecting reported result	
Vinha, 2016	Serious	Serious	Moderate	Moderate	Low	Low	Low	**Serious**
Liu, 2017	Critical	Serious	Moderate	Serious	Serious	Critical	No information	**No information**

TABLE 4 - Grade evaluation of the outcomes apnea-hypopnea index and oxygen desaturation index

Outcome	Number of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Certainty
Apnea-Hypopnea Index	2	Observational studies (before-after studies)	Serious[a]	Very serious[b]	Serious[c]	Very serious[d]	Publication bias strongly suspected[e]	⊕◯◯◯ VERY LOW
Oxygen Desaturation Index	2	Observational studies (before-after studies)	Serious[a]	Very serious[b]	Very serious[f]	Very serious[d]	Publication bias strongly suspected[e]	⊕◯◯◯ VERY LOW

[a]The evidence has been downgraded by one level because of serious concern regarding the risk of bias. According to ROBINS, one included article has serious risk of bias and the other has critical risk of bias.
[b]The evidence has been downgraded by two levels because of very serious concern regarding inconsistency. It is not possible to ascertain whether estimates vary across studies, confidence intervals show minimal or no overlap or the statistical heterogeneity is large.
[c]The evidence has been downgraded by one level because of serious concern regarding indirectness. There is no comparison between surgical maxillary expansion and other alternative intervention.
[d]The evidence has been downgraded by two levels because of very serious concern regarding imprecision. There is a lack of confidence intervals. The results of the standard deviations having the means as a reference are large in both studies. Moreover, the results of both studies are based on a sample with a limited number of participants.
[e]The evidence has been downgraded by one level because publication bias is strongly suspected. A limited number of articles (only two) has been published. The evidence also comes from small studies with a limited number of participants.
[f]The evidence has been downgraded by two levels because of very serious concern regarding indirectness. There is indirectness regarding the outcome. The studies evaluate sleep apnea, but this outcome is oxygen desaturation index. Moreover, there is no comparison between surgical maxillary expansion and other alternative intervention.

SUPPLEMENTARY FILE 1 - Search strategy for each database

Database	Search Strategy
Cochrane	#1 Obstructive Sleep Apnea #2 Obstructive Sleep Apneas #3 Obstructive Sleep Apnea Syndrome #4 OSAHS #5 Obstructive Syndrome Sleep Apnea #6 Sleep Apnea Hypopnea Syndrome #7 Obstructive Sleep Apnea Syndrom #8 Upper Airway Resistance Sleep Apnea Syndrome #9 Sleep Apnea Syndrome Upper Airway Resistance #10 sleep apnea #11 hypopnea syndrome #12 OSA #13 sleep disorder #14 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 #15 Palatal Expansion Technique #16 Palatal Expansion Techniques #17 Palatal Expansion Technics #18 Maxillary Expansion #19 Rapid palatal expansion #20 rapid maxillary expansion #21 maxillomandibular expansion #22 distraction osteogenesis maxillary expansion #23 surgically assisted rapid maxillary expansion #24 SARPE #25 maxillary skeletal expander #26 MSE #27 microimplant-assisted rapid palatal expander #28 mini-implant assisted rapid palatal expansion #29 mini-screw assisted rapid palatal expansion #30 MARPE #31 microimplant-assisted rapid maxillary expander #32 implant-supported rapid maxillary expansion #33 mini-implant anchorage on bone-borne palatal expansion #34 bone-borne palatal expansion #35 miniscrew assisted rapid palatal expansion #36 #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 #37 #14 and #36
Google Scholar	Obstructive Sleep Apnea OR Obstructive Sleep Apneas OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Obstructive Syndrome Sleep Apnea OR Sleep Apnea Hypopnea Syndrome OR Obstructive Sleep Apnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR Sleep Apnea Syndrome Upper Airway Resistance OR sleep apnea OR hypopnea syndrome OR OSA OR sleep disorder AND Palatal Expansion Technique OR Palatal Expansion Techniques OR Palatal Expansion Technic OR Palatal Expansion Technics OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR distraction osteogenesis maxillary expansion OR surgically assisted rapid maxillary expansion OR “SARPE” OR maxillary skeletal expander OR MSE OR microimplant-assisted rapid palatal expander OR mini-implant assisted rapid palatal expansion OR “mini-screw assisted rapid palatal expansion” OR “MARPE” OR microimplant-assisted rapid maxillary expander OR mini-implant assisted rapid maxillary expansion OR mini-screw assisted rapid maxillary expansion OR MARME OR implant-supported rapid maxillary expansion OR mini-implant anchorage on bone-borne palatal expansion OR bone-borne palatal expansion OR miniscrew assisted rapid palatal expansion

Lilacs	Obstructive Sleep Apnea syndrome OR hypopnea OR disorder OR airway AND Palatal Expansion Technique OR maxillary expansion OR sarpe OR marpe OR marme OR mse OR miniimplant OR miniscrew OR microimplant OR surgical OR surgically
MedLine Ovid	Obstructive Sleep Apnea OR Obstructive Sleep Apneas OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Sleep Apnea Hypopnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR OSA OR sleep disorder OR sleep apnea OR Sleep Apnea Syndrome Upper Airway Resistance OR apnea AND Palatal Expansion Technique OR Palatal Expansion Technics OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR distraction osteogenesis maxillary expansion OR surgically assisted rapid maxillary expansion OR maxillary skeletal expander OR microimplant-assisted rapid palatal expander OR mini-implant assisted rapid palatal expansion OR mini-screw assisted rapid palatal expansion OR implant-supported rapid maxillary expansion OR mini-implant anchorage on bone-borne palatal expansion OR bone-borne palatal expansion OR miniscrew assisted rapid palatal expansion OR mini-screw assisted rapid maxillary expansion OR mini-implant assisted rapid maxillary expansion OR microimplant-assisted rapid maxillary expander OR marpe OR sarpe OR marme OR mse
Pubmed	Obstructive Sleep Apnea OR Obstructive Sleep Apneas OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Obstructive Syndrome Sleep Apnea OR Sleep Apnea Hypopnea Syndrome OR Obstructive Sleep Apnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR Sleep Apnea Syndrome Upper Airway Resistance OR sleep apnea OR hypopnea syndrome OR OSA OR sleep disorder AND Palatal Expansion Technique OR Palatal Expansion Techniques OR Palatal Expansion Technic OR Palatal Expansion Technics OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR distraction osteogenesis maxillary expansion OR surgically assisted rapid maxillary expansion OR “SARPE” OR maxillary skeletal expander OR MSE OR microimplant-assisted rapid palatal expander OR mini-implant assisted rapid palatal expansion OR “mini-screw assisted rapid palatal expansion” OR “MARPE” OR microimplant-assisted rapid maxillary expander OR mini-implant assisted rapid maxillary expansion OR mini-screw assisted rapid maxillary expansion OR MARME OR implant-supported rapid maxillary expansion OR mini-implant anchorage on bone-borne palatal expansion OR bone-borne palatal expansion OR miniscrew assisted rapid palatal expansion
Scopus	“Obstructive Sleep Apnea” OR “Obstructive Sleep Apneas” OR “Obstructive Sleep Apnea Syndrome” OR OSAHS OR “Obstructive Syndrome Sleep Apnea” OR “Sleep Apnea Hypopnea Syndrome” OR “Obstructive Sleep Apnea Syndrome” OR “Upper Airway Resistance Sleep Apnea Syndrome” OR “Sleep Apnea Syndrome Upper Airway Resistance” OR “sleep apnea” OR “hypopnea syndrome” OR OSA OR “sleep disorder” AND **“**Palatal Expansion Technique” OR “Palatal Expansion Techniques” OR “Palatal Expansion Technic” OR “Palatal Expansion Technics” OR “Maxillary Expansion” OR “Rapid palatal expansion” OR “rapid maxillary expansion” OR “maxillomandibular expansion” OR “distraction osteogenesis maxillary expansion” OR “surgically assisted rapid maxillary expansion” OR SARPE OR “maxillary skeletal expander” OR MSE OR “microimplant-assisted rapid palatal expander” OR “mini-implant assisted rapid palatal expansion” OR “mini-screw assisted rapid palatal expansion” OR MARPE OR “microimplant-assisted rapid maxillary expander” OR “mini-implant assisted rapid maxillary expansion” OR “mini-screw assisted rapid maxillary expansion” OR MARME OR “implant-supported rapid maxillary expansion” OR “mini-implant anchorage on bone-borne palatal expansion” OR “bone-borne palatal expansion” OR “miniscrew assisted rapid palatal expansion”

U.S. Clinical Trials	Obstructive Sleep Apnea OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Sleep Apnea Hypopnea Syndrome OR Obstructive Sleep Apnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR sleep apnea OR hypopnea syndrome OR OSA OR sleep disorder OR orthodontic AND Palatal Expansion Technique OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR surgically assisted rapid palatal expansion OR mini-implant assisted rapid palatal expansion
Web of Science	Obstructive Sleep Apnea OR Obstructive Sleep Apneas OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Obstructive Syndrome Sleep Apnea OR Sleep Apnea Hypopnea Syndrome OR Obstructive Sleep Apnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR Sleep Apnea Syndrome Upper Airway Resistance OR sleep apnea OR hypopnea syndrome OR OSA OR sleep disorder AND Palatal Expansion Technique OR Palatal Expansion Techniques OR Palatal Expansion Technic OR Palatal Expansion Technics OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR distraction osteogenesis maxillary expansion OR surgically assisted rapid maxillary expansion OR SARPE OR maxillary skeletal expander OR MSE OR microimplant-assisted rapid palatal expander OR mini-implant assisted rapid palatal expansion OR “mini-screw assisted rapid palatal expansion” OR microimplant-assisted rapid maxillary expander OR mini-implant assisted rapid maxillary expansion OR mini-screw assisted rapid maxillary expansion OR MARME OR implant-supported rapid maxillary expansion OR mini-implant anchorage on bone-borne palatal expansion OR bone-borne palatal expansion OR miniscrew assisted rapid palatal expansion

SUPPLEMENTARY FILE 2 - Articles excluded following full text evaluation and reasons for exclusion

1. Akay MC, Aras I, Günbay T, Aras A. Does transpalatal distraction affect pharyngeal airway dimensions and related soft tissues? J Oral Maxillofac Surg, 2014; 72(8):1559-1564.
   Reason for exclusion: The study did not assess obstructive sleep apnea.
2. Bach N, Tuomilehto H, Gauthier C, Papadakis A, Remise C, Lavigne F, Lavigne GJ, HUYNH N. The effect of surgically assisted rapid maxillary expansion on sleep architecture: an exploratory risk study in healthy young adults. 2013; 40(11):818-825.
   Reason for exclusion: The sample did not show obstructive sleep apnea in T1.
3. Bianchi FA, Gerbino G, Corsico M, Schellino E, Barla N, Verza L, Ramieri G. Soft, hard-tissues and pharyngeal airway volume changes following maxillomandibular transverse osteodistraction: Computed tomography and three-dimensional laser scanner evaluation. 2017; 45(1):47-55.
   Reason for exclusion: The study did not assess obstructive sleep apnea.
4. Cistulli PA, Palmisano RG, Wilcox I, Sullivan CE. Treatment of snoring and obstructive sleep apnoea by rapid maxillary expansion. 1996; 26:428-429.
   Reason for exclusion: This study is a case report.
5. Cistulli PA, Palmisano RG, Poole MD. Treatment of obstructive sleep apnea syndrome by rapid maxillary expansion. 1998; 21(8):831-835.
   Reason for exclusion: The sample of this study included patients under 19 years old.
6. Foltan R, Hoffmannova J, Pavlikova G, Hanzelka T, Klina K, Horka E, Adamek S, Sedy J. The influence of orthognathic surgery on ventilation during sleep. 2011; 40(2):146-149.
   Reason for exclusion: The sample did not show obstructive sleep apnea in T1.
7. Guilleminault C, Li KK. Maxillomandibular expansion for the treatment of sleep-disordered breathing: Preliminary result. 2004; 114(5):893-896.
   Reason for exclusion: The sample of this study included patients under 19 years old.
8. Kasey KL, Powell NB, Riley RW, Guilleminault C. Distraction Osteogenesis in adult obstructive sleep apnea surgery: a preliminary report. 2002; 60:6-10.
   Reason for exclusion: The intervention was not rapid maxillary expansion.

9. Menegat F, Monnazzi MS, Silva BN, de Moraes M, Gabrielli MAC, Pereira VA. Assessment of nasal obstruction symptoms using the NOSE scale after surgically assisted rapid maxillary expansion. 2015; 44(11)1346-1350.
   Reason for exclusion: The study did not assess obstructive sleep apnea

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SUPPLEMENTARY FILE 3 - Details of ROBINS-I evaluation

Vinha, 2016	
Confounding SERIOUS	- Despite circumference of the neck and BMI was measured before and after intervention, data about nasal permeability, blood pressure and blood sugar levels were not presented. - Allergic process could reduce nasal permeability. No data was available about allergic process in T1 and T2 besides arterial hypertension and diabetes could interfere in results, the study didn't present this information. - Patients were selected in august 2011 to April 2014, but treatment duration was not informed.
Selecting participants for the study SERIOUS	- Did not mention individuals who refused to participate in the study, even as no adjustments to avoid bias in selection. No available information about professionals who screened patients. - No information about sagittal classification of the patients (Class I, II or III). Mandibular retrognathism are more associated to obstructive sleep apnea than prognathism and mandibular orthognathism. It is possible to infer that the patient illustrated in the article (Fig. 1) presents mandibular prognathism.
Classifying the interventions MODERATE	- Only a group was submitted to an intervention, without comparison group, the study could not be compared with a RCT.
Deviations from intended intervention MODERATE	- No deviations from intended intervention was observed, but without a comparison group the study could not be compared with a RCT.
Missing data LOW	- All parameters cited in "Materials and Methods" were made available in the "Results" with mean, standard deviation, confidence interval, and p value.
Measuring outcomes LOW	- For the parameters related to apnea, the text was clear about the evaluator's blinding.
Selecting reported result LOW	- For the parameters related to apnea, the text was clear about the evaluator's blinding.
Overall risk of bias judgment	**Serious**

5 CONSIDERAÇÕES FINAIS

A revisão sistemática, topo da pirâmide de evidências científicas, além de apontar evidências, identifica aspectos e conteúdos que devem ser melhor explorados por meio de estudos de qualidade. Apesar da pertinência da pergunta de pesquisa proposta neste trabalho, os estudos publicados até o momento, foram incapazes de fornecer uma resposta confiável ao tema proposto.

Sugere-se que ocorra uma melhora na AOS quando há realização de ERM em adultos, porém, os achados são insuficientes para tal afirmação. A AOS têm se tornado, cada dia mais, alvo de pesquisas científicas, devido à prevalência, que tem aumentado e por ser um problema de saúde pública. Um ensaio clínico randomizado, bem desenhado, com limitações, principalmente, devido a incapacidade de cegamento dos pesquisadores em todos os tempos, como o proposto neste trabalho, poderia elucidar melhor as questões relacionadas à ERM e AOS.

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ANEXO A – Protocolo Prospero

PROSPERO
International prospective register of systematic reviews

NHS National Institute for Health Research

Do palatal expansion techniques improve obstructive sleep apnea in adults? A systematic review and meta-analysis

Livia Oliveira, Dauro Oliveira, Lucas Abreu, Giordani Silveira

Citation

Livia Oliveira, Dauro Oliveira, Lucas Abreu, Giordani Silveira. Do palatal expansion techniques improve obstructive sleep apnea in adults? A systematic review and meta-analysis. PROSPERO 2018 CRD42018087013 Available from: http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42018087013

Review question

What is the effect of palatal expansion techniques on obstructive sleep apnea in adults?

Searches

Searches in the electronic databases LILACS/Bireme, PubMed, Web of Science, Cochrane clinical trials, Scopus, MEDLINE ovid, Embase, Google Scholar, Controlled trials database of clinical trials will be conducted from their date of inception to January 17, 2018.

The search strategy will consist of terms relating to or describing the intervention and the outcome. The search terms will be tailored for each database and will be used along with Boolean operators (AND / OR). Restrictions on language or date of publication will not be imposed.. The searches will be re-run just before the final analyses and further studies retrieved will be included.

Types of study to be included

Randomised trials to assess the benefits of treatments. Likely observational studies will supplement the review

Condition or domain being studied

Obstructive Sleep Apnea. Palatal Expansion Technique. Individuals without craniofacial growth. Results in apnea and hypopnea index (IAH).

Participants/population

Inclusion: adults (individuals > 19 years of age), individuals without craniofacial growth.
Exclusion: adolescents (individuals ? 19 years of age), individuals with craniofacial growth.

Intervention(s), exposure(s)

Palatal Expansion Technique. The intervention could be done by different approaches: conventional palatal expansion technique with appliances, expanders, mini-implant assisted rapid palatal expansion or surgically assisted rapid maxillary expansion.

Comparator(s)/control

Control group (no treatment) or other palatal expansion technique.

Primary outcome(s)

Palatal expansion technique reduces apnea and hypopnea index (IAH).

Secondary outcome(s)

Palatal expansion technique reduces oxygen saturation as well as the scores of the Epworth sleepiness scale and the nasal obstructive scale (NOSE).

Data extraction (selection and coding)

Abstracts of studies retrieved in the searches and those retrieved from additional sources will be screened independently by two review team members according to the eligibility criteria for inclusion or exclusion. The full text of these potentially eligible studies will be retrieved and independently assessed for eligibility by the same two team members. Any disagreement between them regarding the eligibility of particular studies will be resolved through discussion with a third reviewer.
A standardized and pre-piloted form will be used to extract data from the included studies for assessment of study quality and evidence synthesis. Extracted information will include: authors' name and publication date, study setting; study population and participants' demographic and baseline characteristics; details of the intervention and control conditions; study methodology; recruitment and study completion rates; Outcomes and periods of measurement; indicators of acceptability to users; suggested mechanisms of intervention action and information for risk assessment of bias will be also extracted. Two review authors will extract data independently. Discrepancies will be identified and resolved through discussion (with a third author when necessary). Missing data will be requested by means of contact with study authors.

Risk of bias (quality) assessment

Risk of bias will be carried out by means of the Cochrane Risk of Bias Tool. Sequence generation, allocation concealment, blinding, attrition, selective reporting and other bias will be evaluated.

Strategy for data synthesis

A quantitative synthesis will be carried out if the included studies are sufficiently homogenous.

Analysis of subgroups or subsets

If the necessary data are available, subgroup analyses will be done, especially with regard to different types of intervention.

Contact details for further information

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Organisational affiliation of the review

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Anticipated or actual start date

20 December 2017

Anticipated completion date

31 August 2018

Funding sources/sponsors

None

Conflicts of interest

Language

English

PROSPERO
International prospective register of systematic reviews

NHS National Institute for Health Research

Country
Brazil

Stage of review
Review_Ongoing

Subject index terms status
Subject indexing assigned by CRD

Subject index terms
Adult; Humans; Palatal Expansion Technique; Polysomnography; Sleep Apnea, Obstructive

Date of registration in PROSPERO
31 January 2018

Date of publication of this version
31 January 2018

Details of any existing review of the same topic by the same authors

Stage of review at time of this submission

Stage	Started	Completed
Preliminary searches	Yes	No
Piloting of the study selection process	Yes	No
Formal screening of search results against eligibility criteria	Yes	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

Versions
31 January 2018

ANEXO B – Mapeamento conceitual para busca avançada

Base de dados	Estratégia de busca	
Cochrane	#1	Obstructive Sleep Apnea
	#2	Obstructive Sleep Apneas
	#3	Obstructive Sleep Apnea Syndrome
	#4	OSAHS
	#5	Obstructive Syndrome Sleep Apnea
	#6	Sleep Apnea Hypopnea Syndrome
	#7	Obstructive Sleep Apnea Syndrom
	#8	Upper Airway Resistance Sleep Apnea Syndrome
	#9	Sleep Apnea Syndrome Upper Airway Resistance
	#10	sleep apnea
	#11	hypopnea syndrome
	#12	OSA
	#13	sleep disorder
	#14	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13
	#15	Palatal Expansion Technique
	#16	Palatal Expansion Techniques
	#17	Palatal Expansion Technics
	#18	Maxillary Expansion
	#19	Rapid palatal expansion
	#20	rapid maxillary expansion
	#21	maxillomandibular expansion
	#22	distraction osteogenesis maxillary expansion
	#23	surgically assisted rapid maxillary expansion
	#24	SARPE
	#25	maxillary skeletal expander
	#26	MSE
	#27	microimplant-assisted rapid palatal expander
	#28	mini-implant assisted rapid palatal expansion
	#29	mini-screw assisted rapid palatal expansion
	#30	MARPE
	#31	microimplant-assisted rapid maxillary expander
	#32	implant-supported rapid maxillary expansion
	#33	mini-implant anchorage on bone-borne palatal expansion
	#34	bone-borne palatal expansion
	#35	miniscrew assisted rapid palatal expansion
	#36	#15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35
	#37	#14 and #36

Google Scholar	Obstructive Sleep Apnea OR Obstructive Sleep Apneas OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Obstructive Syndrome Sleep Apnea OR Sleep Apnea Hypopnea Syndrome OR Obstructive Sleep Apnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR Sleep Apnea Syndrome Upper Airway Resistance OR sleep apnea OR hypopnea syndrome OR OSA OR sleep disorder AND Palatal Expansion Technique OR Palatal Expansion Techniques OR Palatal Expansion Technic OR Palatal Expansion Technics OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR distraction osteogenesis maxillary expansion OR surgically assisted rapid maxillary expansion OR "SARPE" OR maxillary skeletal expander OR MSE OR microimplant-assisted rapid palatal expander OR mini-implant assisted rapid palatal expansion OR "mini-screw assisted rapid palatal expansion" OR "MARPE" OR microimplant-assisted rapid maxillary expander OR mini-implant assisted rapid maxillary expansion OR mini-screw assisted rapid maxillary expansion OR MARME OR implant-supported rapid maxillary expansion OR mini-implant anchorage on bone-borne palatal expansion OR bone-borne palatal expansion OR miniscrew assisted rapid palatal expansion
Lilacs	Obstructive Sleep Apnea syndrome OR hypopnea OR disorder OR airway AND Palatal Expansion Technique OR maxillary expansion OR sarpe OR marpe OR marme OR mse OR miniimplant OR miniscrew OR microimplant OR surgical OR surgically
MedLine Ovid	Obstructive Sleep Apnea OR Obstructive Sleep Apneas OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Sleep Apnea Hypopnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR OSA OR sleep disorder OR sleep apnea OR Sleep Apnea Syndrome Upper Airway Resistance OR apnea AND Palatal Expansion Technique OR Palatal Expansion Technics OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR distraction osteogenesis maxillary expansion OR surgically assisted rapid maxillary expansion OR maxillary skeletal expander OR microimplant-assisted rapid palatal expander OR mini-implant assisted rapid palatal expansion OR mini-screw assisted rapid palatal expansion OR implant-supported rapid maxillary expansion OR mini-implant anchorage on bone-borne palatal expansion OR bone-borne palatal expansion OR miniscrew assisted rapid palatal expansion OR mini-screw assisted rapid maxillary expansion OR mini-implant assisted rapid maxillary expansion OR microimplant-assisted rapid maxillary expander OR marpe OR sarpe OR marme OR mse
Pubmed	Obstructive Sleep Apnea OR Obstructive Sleep Apneas OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Obstructive Syndrome Sleep Apnea OR Sleep Apnea Hypopnea Syndrome OR Obstructive Sleep Apnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR Sleep Apnea Syndrome Upper Airway Resistance OR sleep apnea OR hypopnea syndrome OR OSA OR sleep disorder AND Palatal Expansion Technique OR Palatal Expansion Techniques OR Palatal Expansion Technic OR Palatal Expansion Technics OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR distraction osteogenesis maxillary expansion OR surgically assisted rapid maxillary expansion OR "SARPE" OR maxillary skeletal expander OR MSE OR microimplant-assisted rapid palatal expander OR mini-implant assisted rapid palatal expansion OR "mini-screw assisted rapid palatal expansion" OR "MARPE" OR microimplant-assisted rapid maxillary expander OR mini-implant assisted rapid maxillary expansion OR mini-screw assisted rapid maxillary expansion OR MARME OR implant-supported rapid maxillary expansion OR mini-implant anchorage on bone-borne palatal expansion OR bone-borne palatal expansion OR miniscrew assisted rapid palatal expansion

Scopus	"Obstructive Sleep Apnea" OR "Obstructive Sleep Apneas" OR "Obstructive Sleep Apnea Syndrome" OR OSAHS OR "Obstructive Syndrome Sleep Apnea" OR "Sleep Apnea Hypopnea Syndrome" OR "Obstructive Sleep Apnea Syndrome" OR "Upper Airway Resistance Sleep Apnea Syndrome" OR "Sleep Apnea Syndrome Upper Airway Resistance" OR "sleep apnea" OR "hypopnea syndrome" OR OSA OR "sleep disorder" AND **"**Palatal Expansion Technique" OR "Palatal Expansion Techniques" OR "Palatal Expansion Technic" OR "Palatal Expansion Technics" OR "Maxillary Expansion" OR "Rapid palatal expansion" OR "rapid maxillary expansion" OR "maxillomandibular expansion" OR "distraction osteogenesis maxillary expansion" OR "surgically assisted rapid maxillary expansion" OR SARPE OR "maxillary skeletal expander" OR MSE OR "microimplant-assisted rapid palatal expander" OR "mini-implant assisted rapid palatal expansion" OR "mini-screw assisted rapid palatal expansion" OR MARPE OR "microimplant-assisted rapid maxillary expander" OR "mini-implant assisted rapid maxillary expansion" OR "mini-screw assisted rapid maxillary expansion" OR MARME OR "implant-supported rapid maxillary expansion" OR "mini-implant anchorage on bone-borne palatal expansion" OR "bone-borne palatal expansion" OR "miniscrew assisted rapid palatal expansion"
U.S. Clinical Trials	Obstructive Sleep Apnea OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Sleep Apnea Hypopnea Syndrome OR Obstructive Sleep Apnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR sleep apnea OR hypopnea syndrome OR OSA OR sleep disorder OR orthodontic AND Palatal Expansion Technique OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR surgically assisted rapid palatal expansion OR mini-implant assisted rapid palatal expansion
Web of Science	Obstructive Sleep Apnea OR Obstructive Sleep Apneas OR Obstructive Sleep Apnea Syndrome OR OSAHS OR Obstructive Syndrome Sleep Apnea OR Sleep Apnea Hypopnea Syndrome OR Obstructive Sleep Apnea Syndrome OR Upper Airway Resistance Sleep Apnea Syndrome OR Sleep Apnea Syndrome Upper Airway Resistance OR sleep apnea OR hypopnea syndrome OR OSA OR sleep disorder AND Palatal Expansion Technique OR Palatal Expansion Techniques OR Palatal Expansion Technic OR Palatal Expansion Technics OR Maxillary Expansion OR Rapid palatal expansion OR rapid maxillary expansion OR maxillomandibular expansion OR distraction osteogenesis maxillary expansion OR surgically assisted rapid maxillary expansion OR SARPE OR maxillary skeletal expander OR MSE OR microimplant-assisted rapid palatal expander OR mini-implant assisted rapid palatal expansion OR "mini-screw assisted rapid palatal expansion" OR microimplant-assisted rapid maxillary expander OR mini-implant assisted rapid maxillary expansion OR mini-screw assisted rapid maxillary expansion OR MARME OR implant-supported rapid maxillary expansion OR mini-implant anchorage on bone-borne palatal expansion OR bone-borne palatal expansion OR miniscrew assisted rapid palatal expansion