UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ODONTOLOGIA DE BAURU

ARTHUR CÉSAR DE MEDEIROS ALVES

Three-dimensional analysis of the dentoalveolar effects of slow and rapid maxillary expansion in bilateral complete cleft lip and palate: a randomized clinical trial

Análise tridimensional dos efeitos dentoalveolares das expansões maxilares lenta e rápida nas fissuras labiopalatinas completas bilaterais: um ensaio clínico randomizado

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

Orientador: Profª. Drª. Daniela Gamba Garib Carreira

Versão corrigida

BAURU

2014

Alves, Arthur César de Medeiros

AL87t

Three-dimensional analysis of the dentoalveolar effects of slow and rapid maxillary expansion in bilateral complete cleft lip and palate: a randomized clinical trial / Arthur César de Medeiros Alves. – Bauru, 2014.

90 p. : il. ; 31cm.

Dissertação (Mestrado) – Faculdade de Odontologia de Bauru. Universidade de São Paulo

Orientador: Profª. Drª. Daniela Gamba Garib Carreira

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DEDICATÓRIA

É com muito carinho e gratidão que dedico este trabalho:

aos meus amados pais Antonio e Lucilene (in memorian),
por sempre me apoiarem na difícil decisão de estudar fora,
por confiarem no meu potencial e nas minhas capacidades,
por todo o carinho, preocupações e cuidados fraternos, e
por me ajudarem significantemente a realizar esse sonho.

aos meus queridos e estimados irmãos Juliana e Gabriel,
por me fazerem rir e tornarem os meus dias mais felizes,
pelas ligações, cartas e mensagens que nunca precisei pedir,
por serem essas pessoas tão presentes na minha vida, e
por compartilharem alegremente essa conquista comigo.

Amo imensamente cada um de vocês.

AGRADECIMENTOS

*A **Deus**, que tem me proporcionado inúmeras conquistas pessoais e profissionais com Sua bondade infinita. Obrigado, Senhor, pelos aprendizados de vida, e por dar-me meios de tentar ser um ser humano cada vez melhor.*

*Aos meus amados pais **Antonio** e **Lucilene**, por me conceberem, me protegerem, me educarem, me apoiarem nas minhas decisões e me darem todo o amor que qualquer pessoa precisa para se sentir viva.*

*Aos meus queridos irmãos **Juliana** e **Gabriel**, por me transmitirem alegria diariamente através dos seus risos e por sempre se fazerem presentes na minha vida, mesmo diante da distância física que nos separa.*

*À minha companheira **Olga**, pelo carinho e chamego, pelos confortos e consolos, por cada segundo que me fez companhia, presencialmente ou por telefone; e por acreditar junto comigo que um relacionamento é, sim, capaz de superar fronteiras, quando existe respeito, fidelidade e sentimentos verdadeiros entre duas criaturas que se amam.*

*A todos que compõem as **famílias Fernandes** e **Alves**, por sempre me acolherem fraternamente, por vibrarem cada conquista minha como se fossem suas, e por aguardarem ansiosos o dia em que retornarei definitivamente para o "ninho".*

*Aos meus **amigos** da infância, da época do colégio e do tempo da graduação em Odontologia, por cultivarem comigo uma amizade duradoura e sincera que nem o tempo ou a distância estão sendo capazes de atrapalhar.*

À minha querida orientadora **Daniela Garib**, que me viu engatinhar na Ortodontia, e com seu instinto materno, acolheu-me em seus braços e educou-me cientificamente, ensinando-me tudo o que sabe com seu jeito sereno e inspirador.

Ao estimado e respeitado professor **Guilherme Janson**, por ensinar-me os passos para a realização de uma Ortodontia baseada em evidências científicas, e por servir-me de exemplo de profissional que ama e se dedica veemente no que faz.

Ao querido professor **José Fernando Castanha Henriques**, pela enorme contribuição na minha formação docente através dos seminários supervisionados ministrados durante o curso de mestrado, e por ensinar-me generosamente parte do conhecimento ortodôntico que adquiriu após décadas de experiência trabalhando nessa Ciência e Arte.

Ao professor **Marcos Roberto de Freitas**, que me inspirou e sempre me incentivou a aprimorar as minhas habilidades manuais na arte de dobrar fios ortodônticos por meio das aulas laboratoriais de adestramento manual.

Ao professor **Arnaldo Pinzan**, pela consideração e respeito que sempre demonstrou por mim, desde o início do Mestrado; e por desmistificar, através das suas aulas e seminários, o complexo conhecimento acerca do crescimento craniofacial e do desenvolvimento dos arcos dentários.

Ao professor **Renato Rodrigues de Almeida**, pelas vezes em que dedicou minutos dos seus dias para humildemente chamar-me em sua sala e ensinar-me valiosos conhecimentos sobre a prevenção e interceptação de más oclusões; ou, até mesmo, contar-me seus aprendizados e experiências de vida, servindo-me de um grande exemplo de pessoa, profissional e anfitrião.

Ao professor **José Roberto Pereira Lauris**, *pelas muitas vezes em que gentilmente se reuniu comigo e pacientemente me explicou de forma tão clara os testes estatísticos necessários para a obtenção dos resultados do meu estudo.*

À querida **Vera Purgato**, *pela competência com que resolveu os problemas acadêmicos concerne ao curso de Mestrado, e por ser um importante elemento de ligação entre alunos e professores.*

Ao estimado **Luiz Sérgio Vieira**, *pelos valiosos ensinamentos técnicos na confecção de aparelhos ortodônticos fixos e removíveis, pela parceria no desenvolvimento de materiais didáticos, e por servir de exemplo de profissional que busca atualização constante do conhecimento científico.*

A minha amiga **Cléo Vieira**, *por sempre me receber alegremente na clínica de Ortodontia, pela confiança em mim e no meu trabalho, e pelas inúmeras vezes em que, como uma psicóloga nata, me ouviu, me entendeu, e me deu os melhores conselhos concerne aos problemas pessoais ou do curso de Mestrado.*

Ao estimado **Wagner Baptista**, *pela forte amizade que temos cultivado desde o início da nossa convivência, pelos apelidos "carinhosos"; e pelas inúmeras vezes em que se mostrou solícito para ajudar na confecção dos aparelhos dos pacientes da clínica de Ortodontia.*

Ao querido **Daniel Bonné**, *pelos risos proporcionados, pelo respeito e carinho que sempre demonstrou por mim, e pela formatação e impressão da dissertação de Mestrado.*

*Aos meus **colegas do curso de mestrado**, Ana Liesel, Bruna Furquim, Camilla Fonçatti, Caroline Tckaz, Louise Resti Calil, Mayara Rizzo, Murilo Matias, Rodrigo Higa, Vinicius Laranjeiras e Waleska Caldas, por me ajudarem a superar as angústias e tensões ora sentidas, e por compartilharem comigo os alívios, as alegrias, surpresas e conquistas proporcionados pelo curso de Mestrado durante esses dois anos que, repentinamente, se passaram.*

*Agradecimento especial à minha querida amiga **Louise Resti Calil**, por sempre me tratar como o seu segundo irmão, mesmo diante da inexistência de consanguinidade, pela incansável companhia, e pela importantíssima ajuda nos atendimentos clínicos dos pacientes da amostra do meu estudo.*

*Aos **colegas do curso de doutorado da Faculdade de Odontologia de Bauru**, Aldo Otazu, Caroline Bronffman, Cíntia Junqueira, Daniela Pupulin, Diego Lorenzoni, Fernanda Pinelli, Gustavo Siécola, Larissa Bressane, Lucas Mendes, Marília Yatabe, Thaís Rocha e William Guirro, por todas as orientações e sugestões dadas durante esses dois anos de intensas atividades, pela agradável companhia nos momentos de distração, e por sempre me tratarem como um integrante ativo da turma de vocês.*

*Agradecimento especial ao meu estimado amigo **Diego Coelho Lorenzoni**, que, como um irmão mais velho, me fez companhia e me deu sábios conselhos durante todo o tempo que se fez presente em Bauru. Agradeço por firmar comigo uma forte parceria pautada de muita amizade, respeito e consideração.*

*As minhas amigas **Priscila Vaz Ayub** e **Amanda Sayuri Cardoso Ohashi**, por dedicarem algumas tardes e noites dos seus dias para me ensinarem generosamente cada um dos passos necessários para a digitalização e medição dos modelos digitais tridimensionais avaliados nesse estudo.*

*A **FAPESP**, pela aprovação do meu projeto de pesquisa (processo 2013/08193-2), pelo apoio financeiro e incentivo ao desenvolvimento da Ciência.*

*À **banca examinadora** da minha dissertação de Mestrado, Drª Daniela Gamba Garib Carreira, Dr. Guilherme Janson, Drª Araci Malagodi de Almeida e Dr. David Normando, por humildemente aceitarem o convite de participação, e por contribuírem significantemente para o aprimoramento deste trabalho através de suas valiosas sugestões e críticas.*

*Aos **avaliadores suplentes** da minha dissertação, Terumi Okada Ozawa, Rita de Cássia Moura Carvalho Lauris, Sergei Godeiro Fernandes Rabelo Caldas e Hallissa Simplício Gomes Pereira, pela gentileza de se disporem a avaliar este trabalho, diante da ausência de algum dos examinadores titulares da banca.*

*Ao **setor de Ortodontia do Centrinho**, representado pelos professores, profissionais ortodontistas, auxiliares de consultório, funcionários e residentes, por serem sempre tão acolhedores e receptivos comigo desde o primeiro dia em que entrei no Hospital, ainda como residente do curso de Atualização em Ortodontia Preventiva e Interceptiva.*

*Agradecimento especial à minha querida professora-madrinha **Araci Malagodi de Almeida**, por toda consideração, amparo, cuidado e carinho de segunda mãe, e por gentilmente dividir comigo a preciosa amostra da sua tese de doutorado.*

*À amiga **Elisa Maria da Silva**, e demais funcionários da central de agendamento do Centrinho, pela prontidão nas marcações das consultas dos pacientes que compuseram a amostra do meu estudo.*

*Aos estimados **Rinaldo**, **Rodrigo Ogawa** e **Wilma Aparecida**, pela presteza e rapidez na procura dos modelos de estudo dos pacientes, e pelo escaneamento de alguns modelos digitais tridimensionais avaliados neste trabalho.*

*Ao estimado **Fábio** e demais funcionários do arquivo de prontuários do Centrinho, pela separação dos prontuários para coleta das informações clínicas dos pacientes.*

*À superintendente do Centrinho, **Drª. Regina Amantini**, por permitir que eu desenvolvesse a minha dissertação de Mestrado em uma Instituição tão respeitada e de excelência no tratamento de pacientes com fissuras labiopalatinas e outras anomalias craniofaciais.*

*À **Comissão de pós-graduação** da Faculdade de Odontologia de Bauru, pela excelência com que solucionaram os problemas concerne ao curso de Mestrado e pelas inúmeras vezes em que eficientemente atenderam às minhas necessidades acadêmicas.*

*À diretora e vice-diretor da Faculdade de Odontologia de Bauru, **Prof.ª Dr.ª Maria Aparecida de Andrade** e **Prof. Dr. Carlos Ferreira dos Santos**, pela oportunidade que me foi dada de poder estudar, aprender e gerar conhecimentos utilizando a infraestrutura desta Escola. Agradeço-lhes por dar-me a chance de contribuir, de alguma forma, para o engrandecimento dessa Universidade internacionalmente reconhecida.*

*Aos queridos **pacientes e pais**, por confiarem nas minhas palavras, nas minhas capacidades e no meu conhecimento; por compartilharem comigo as experiências vividas; e por me ensinarem que, por pior que sejam os nossos problemas, sempre é possível estampar um sorriso verdadeiro no rosto quando se tem fé, perseverança e amor à vida.*

A todos que colaboraram indiretamente para a idealização, realização e finalização desse trabalho e que, por ventura, não foram mencionados.

Meu muito obrigado!

"Mestre, depois de pai, é o nome mais nobre e mais doce que um homem pode dar a outro".

Edmondo de Amicis

ABSTRACT

ABSTRACT

Three-dimensional analysis of the dentoalveolar effects of slow and rapid maxillary expansion in bilateral complete cleft lip and palate: a randomized clinical trial

Introduction: The aim of this study was to compare the dentoalveolar effects of slow (SME) and rapid (RME) maxillary expansions in patients with bilateral complete cleft lip and palate. **Methods:** A total of fifty patients with bilateral complete cleft lip and palate diagnosed with maxillary dental arch constriction were randomly and equally divided into two groups. The SME group was comprised by patients who underwent slow maxillary expansion using quad helix appliance, and the RME group was composed by individuals who underwent rapid maxillary expansion using Hyrax expander. Digital dental models were acquired immediately pre-expansion (T1) and 6 months after the active expansion period (T2). Maxillary dental arch widths, arch perimeter, arch length, palatal depth and buccolingual inclination of posterior teeth were measured. Intergroup and inter-phase comparisons were performed with Student's *t* test and paired *t* test, respectively ($p<0.05$). **Results:** Slow and rapid maxillary expansions caused significant and similar increase of arch widths and perimeter. Quad helix appliance showed a significant differential expansion greater in the intercanine width of maxillary dental arch compared to the intermolar width. Rapid maxillary expansion caused a significant decreasing of the arch length and palatal depth. Both appliances promoted similar significant proclination of maxillary canines. No differences were observed between the dentoalveolar effects of slow and rapid maxillary expansion. **Conclusion:** Slow and rapid maxillary expansions seem to cause similar dentoalveolar effects for the correction of maxillary dental arch constriction in patients with bilateral complete cleft lip and palate. Only quad helix appliance produced a differential expansion in the maxillary dental arch.

Key words: Palatal expansion technique. Dental models. Cleft lip. Cleft palate.

Resumo

RESUMO

Introdução: O objetivo do presente trabalho foi comparar os efeitos dentoalveolares das expansões lenta (ELM) e rápida (ERM) da maxila em pacientes com fissuras labiopalatinas completas bilaterais. **Métodos:** Um total de cinquenta pacientes diagnosticados com constrição do arco dentário superior foram aleatoriamente e igualmente divididos em dois grupos. O Grupo ELM foi composto por pacientes submetidos à expansão lenta da maxila com o aparelho quadri-hélice, e o Grupo ERM constituiu-se de indivíduos submetidos à expansão rápida maxilar com o expansor Hyrax. Modelos digitais foram adquiridos imediatamente antes da expansão (T1), e 6 meses após a fase ativa de expansão (T2). A largura do arco dentário superior, o perímetro do arco, o comprimento do arco, a profundidade do palato e as inclinações dos dentes posteriores foram medidos. As comparações intergrupos e interfases foram realizadas por meio do teste *t* de Student e teste *t* pareado, respectivamente ($p<0,05$). **Resultados:** As expansões lenta e rápida da maxila promoveram aumentos similares e significantes na largura e no perímetro do arco dentário superior. O quadri-hélice mostrou uma expansão diferencial significantemente maior na região dos caninos superiores comparado à região dos molares. A expansão rápida da maxila promoveu uma diminuição significante do comprimento do arco e da profundidade do palato. Ambos os grupos apresentaram uma vestibularização significante dos caninos superiores. Não foram observadas diferenças entre os efeitos dentoalveolares das expansões lenta e rápida da maxila. **Conclusão:** As expansões lenta e rápida da maxila parecem promover efeitos dentoalveolares semelhantes para a correção da constrição do arco dentário superior em pacientes com fissuras labiopalatinas completas bilaterais. Apenas o quadri-hélice promoveu uma expansão diferencial no arco dentário superior.

Palavras-chave: Técnica de expansão palatina. Modelos dentários. Fenda labial. Fissura palatina.

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LIST OF ABBREVIATIONS AND ACRONYMS

SME	Slow maxillary expansion
RME	Rapid maxillary expansion
BCLP	Bilateral complete cleft lip and palate
T1	Timing 1
T2	Timing 2
CLP	Cleft lip and palate
I	Inclination
SD	Standard deviation
95% CI	Confidence interval of 95%
AL	Arch length
PD	Palatal depth

LIST OF SYMBOLS

3-3	Intercanine distance at the level of the gingival margin.
4-4	Distance between first deciduous molars at the level of the gingival margin.
5-5	Distance between second deciduous molars at the level of the gingival margin.
6-6	Inter-first permanent molar distance at the level of the gingival margin.
I3	Buccolingual inclination of deciduous canines.
I5	Buccolingual inclination of second deciduous molars.
I6	Buccolingual inclination of first permanent molars.
P3-6	Distance between the most mesial point on the mesial aspects of first permanent molar and deciduous canine of the right side.
P1-3	Distance between the most mesial point on the mesial aspects of the right deciduous canine and the left central incisor.
P1-3’	Distance between the most mesial point on the mesial aspects of deciduous canine and central incisor of the left side.
P3-6’	Distance between the most mesial point on the mesial aspects of first permanent molar and deciduous canine of the left side.

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1 Introduction

1 INTRODUCTION

Bilateral complete cleft lip and palate (BCLP) is also called bilateral incisive transforamen cleft (SPINA et al., 1972). This craniofacial anomaly has a relatively small prevalence in population (GUNDLACH; MAUS, 2006), accounting about 16.5% of all types of oral clefts that may involve the lip and the palate in humans (CAPELOZZA FILHO; DE ALMEIDA; URSI, 1994).

Intraorally, individuals with BCLP often show, at birth, a palate with increased dimensions and divided into three segments (HEIDBUCHEL et al., 1998a). These maxillary segments are usually quite apart from each other and present asymmetric projections (HEIDBUCHEL et al., 1998a).

In order to rehabilitate esthetically and functionally the patients with BCLP, one of the treatment protocols existent is performing the primary lip and palate repair in infancy (MOORE et al., 1988; SILVA FILHO; OZAWA; BORGES, 2007). However, at the same time that these surgical procedures enhance the patient's quality of life, negative influences on the maxillary anteroposterior and transverse growth also occur over time (MOORE et al., 1988; SILVA FILHO; OZAWA; BORGES, 2007).

The transverse changes observed during the growth of these patients consist of maxillary constriction associated or not to posterior crossbites (HEIDBUCHEL et al., 1998b). These dentoskeletal changes occur consequent to the approximation of the maxillary segments due to the absence of midpalatal suture (SILVA FILHO et al., 1989). Additionally, the forces released by the fibrous scars of the surgical procedures contribute to a greater constriction of the maxillary dental arch (FRIEDE, 1998).

Although restriction on transverse growth occurs along all maxillary length, maxillary constriction is more pronounced in the intercanine width of maxilla, because the maxillary segments move performing a medial rotation with the fulcrum located approximately in the maxillary tuberosity region (HARDING; MAZAHERI, 1972; HEIDBUCHEL et al., 1998a; HEIDBUCHEL et al., 1998b).

Considering that the maxilla of these individuals is constricted and are usually associated to posterior crossbites (HEIDBUCHEL; KUIJPERS-JAGTMAN, 1997), the orthodontic treatment for patients with BCLP consists in a maxillary expansion

(FREITAS et al., 2012). These maxillary expansions have been performed in cleft lip and palate (CLP) patients using slow expanders, such as the quad helix appliance and its variations (VASANT; MENON; KANNAN, 2009; AIZENBUD et al., 2012), or rapid expanders (FAÇANHA et al., 2014), such as the Hass (HAAS, 1961) or Hyrax (WEBER, 1970) appliances.

Considering that the maxillary constriction of patients with BCLP is greater in the intercanine width compared to intermolar width, slow maxillary expansion (SME) using quad helix appliance might perform an efficient maxillary expansion in these patients, because the differential activation of the appliance arms might accomplish greater expansion in the anterior region than in the posterior region of maxillary dental arch (DUARTE, 2006). On the other hand, rapid maxillary expansion (RME) using Hyrax appliance, might not be totally effective for the correction of maxillary constriction and posterior crossbites in these patients, because the expander screw shows similar increases in intermolar and intercanine widths (GARIB et al., 2005a). This occur because the screw promotes a parallel opening of the appliance (GARIB et al., 2005a). This symmetric expansion in the anterior and posterior regions might induce Orthodontists to promote excessive overcorrection in the molars region to correct the greater constriction of the intercanine width. This over-expansion of the intermolar distance is not desirable because it can causes negative effects on the periodontium of the anchorage teeth, such as bone dehiscence and gingival recessions in long-term (GREENBAUM; ZACHRISSON, 1982; GARIB et al., 2005b).

There is a lack of clinical studies that evaluated the occlusal effects of slow (VASANT; MENON; KANNAN, 2009; AIZENBUD et al., 2012) and rapid (ISAACSON; MURPHY, 1964; QIAN; DING; YAN, 2002; VASANT; MENON; KANNAN, 2009; FAÇANHA et al., 2014; FIGUEIREDO et al., 2014) maxillary expansion in patients with BCLP. Furthermore, the unique clinical study published (VASANT; MENON; KANNAN, 2009) that compared these two expansion modalities has methodological limitations and moderate risk of bias. Thus, the aim of the current study was to compare the dentoalveolar effects of slow and rapid expansions in patients with bilateral complete cleft lip and palate.

2 ARTICLE

2 ARTICLE

The article presented in this Dissertation was written according to the CONSORT 2010 statement (Annex D) and the American Journal of Orthodontics and Dentofacial Orthopedics instructions and guidelines for article submission (Annex E).

THREE-DIMENSIONAL ANALYSIS OF THE DENTOALVEOLAR EFFECTS OF SLOW AND RAPID MAXILLARY EXPANSION IN BILATERAL COMPLETE CLEFT LIP AND PALATE: A RANDOMIZED CLINICAL TRIAL

ABSTRACT

Introduction: The aim of this “2-arm parallel” trial was to compare the maxillary dental arch changes of slow (SME) and rapid (RME) maxillary expansions in patients with bilateral complete cleft lip and palate (BCLP). **Methods:** Patients with BCLP and maxillary dental arch constriction from a single rehabilitation center were randomly allocated into two groups. Groups SME and RME comprised patients treated with quad helix appliance and Hyrax expander, respectively. Eligibility criteria included ages ranging from 7 to 11 years; lip and palate repair performed from 3 to 24 months of age; need of maxillary expansion prior to secondary alveolar bone grafting; and absence of associated syndromes or previous orthodontic intervention. The primary outcomes were maxillary dental arch widths, arch perimeter, arch length, palatal depth and buccolingual inclination of posterior teeth. The secondary outcome was the differential amount of expansion accomplished at the canine and molar regions. Computer-generated randomization was used. Allocation concealed was done with sequentially, numbered, sealed, opaque envelopes. Blinding was applicable for outcome assessment only. Digital dental models were obtained immediately pre-expansion (T1) and 6 months after the active expansion period (T2). Inter-phase and intergroup comparisons were performed using paired *t* test and Student’s *t* test, respectively ($p<0.05$). **Results:** Eighty-three patients were assessed for eligibility criteria. Sixty-two patients met the eligibility criteria and were randomized in a 1:1 ratio to each group. The mean follow-up period (T1 to T2) was 11 and 7.2 months for SME and RME groups, respectively. Twelve participants were lost during both the enrollment and the follow-up period (6 for each group). A total of fifty patients were analyzed. Both SME and RME groups comprised 25 participants with a mean initial age of 8.8 and 8.9 years, respectively. SME and RME caused significant and similar increase of arch widths and arch perimeter. RME caused a significant decrease of the arch length and palatal depth. Buccal tooth inclination was significant only for maxillary deciduous canines in both groups. No differences were observed between

SME and RME for the primary outcomes. The quad helix appliance showed a significant differential expansion between anterior and posterior regions while Hyrax has not. Serious harm was not observed. **Conclusions:** Differences were not found between the dentoalveolar effects of SME and RME in patients with BCLP. Only quad helix appliance produced a differential expansion in the maxillary dental arch. SME demanded a slight greater therapy time compared to RME.

Registration: The trial was not registered.

Protocol: The protocol was not published before trial commencement.

Funding: Foundation for Research Support of São Paulo State (FAPESP 2013/08193-2).

KEYWORDS: Palatal expansion technique. Dental models. Cleft lip. Cleft palate.

INTRODUCTION

Cleft lip and palate (CLP) is considered the most common craniofacial anomaly in humans.[1] This malformation can involve the upper lip, alveolar ridge or/and the palate and, in general, causes esthetic, functional and psychosocial impairments in different magnitudes, depending of its location and extension.[2] Bilateral complete cleft lip and palate (BCLP) is the most severe type of cleft.[3] In general, patients with BCLP who underwent lip and palate repair at early ages usually show severe deficiencies of maxillary growth, demonstrating maxillary dental arch constrictions and posterior crossbites.[4-8] The orthodontic treatment of patients with BCLP commonly requires maxillary expansion.[9-17] The question that arises is what is the most appropriate modality of expansion for patients with BCLP?

There is no universal protocol for maxillary expansion prior to secondary alveolar bone grafting. Some rehabilitation centers advocate correction of maxillary dental arch constriction with slow maxillary expansion (SME) using quad helix appliance and its variations.[9,18] On the other hand, other authors use rapid maxillary expansion (RME) with Haas-type or Hyrax expanders.[19-22] In patients without oral clefts, SME promotes essentially posterior tooth inclination even though previous studies reported some bone formation in circumaxillary sutures.[23-25] RME releases

higher magnitude of forces and promotes skeletal effects represented by the midpalatal suture opening together with dental movement in noncleft patients.[26-29]

Recent systematic reviews found no robust evidence of differences between SME and RME for the correction of maxillary dental arch constriction and posterior crossbites in noncleft patients.[30,31] A previous study with transmission polariscope observed that SME causes smaller orthopedic effects and greater buccal inclination of molars compared to RME in patients without cleft.[23] No comparisons between the dentoalveolar effects of SME and RME were performed for individuals with BCLP. Only recently, a study including patients with unilateral and bilateral complete cleft lip and palate showed no significant differences between the quad helix appliance and the Hyrax expander for maxillary permanent first molar tipping. However, other dentoalveolar variables must be assessed to a better understanding of the occlusal effects of SME and RME in BCLP patients.[9]

Specific objectives or hypotheses

The aim of the present study was to compare the dentoalveolar effects of slow and rapid maxillary expansions in patients with bilateral complete cleft lip and palate using three-dimensional analyses on digital dental models. The null hypothesis was that SME and RME are not different regarding the maxillary dental arch changes in patients with BCLP.

METHODS

Trial design and any changes after trial commencement

This study was a randomized clinical trial involving two parallel groups randomized with a 1:1 allocation ratio. No changes of methods were necessary after trial commencement.

Participants, eligibility criteria, and settings

Ethical approval was obtained from Research Institutional Board of Hospital for Rehabilitation of Craniofacial Anomalies, University of São Paulo (protocol number 349169).

Consecutive patients were recruited at the Institution, during the period from September of 2011 to September of 2013. Consent was obtained from the participant's legal guardian before their recruitment.

Eligibility criteria for the participants were: patients with bilateral complete cleft lip and palate; ages ranging from 7 to 11 years; lip and palate repair performed from 3 to 24 months of age; and presence of maxillary dental arch constriction and need of maxillary expansion prior to secondary alveolar bone grafting. Exclusion criteria were the presence of associated syndromes and history of previous orthodontic treatment.

Interventions

Orthodontic exams, alginate impressions and installations, follow-up and removals of quad helix appliances and Hyrax expanders were performed by two experienced Orthodontists of the Institution and two Orthodontic residents, during the period from October of 2011 to September of 2014.

At the initial orthodontic exam, the participants of the study and their legal guardians were informed about the need of a maxillary dental arch expansion prior to secondary alveolar bone grafting and they received invitation to participate of the study. Once informed consent was obtained, the patients were randomly allocated into two study groups: slow maxillary expansion group (SME group) or rapid maxillary expansion group (RME group). After at least a month after the initial orthodontic exam, patients returned for installing the expanders.

SME group was treated with slow maxillary expansion using quad helix appliance (Fig. 1). The expander was constructed using 0.036" stainless steel round wires. Molar bands were adapted preferentially on maxillary first permanent molars. When these teeth were partially erupted, second deciduous molars were banded. Quad helix appliance was activated 6 mm (3 mm per side) and subsequent reactivations were performed extraorally at a 2-month interval. The expansion active phase ranged from 4 to 21 months. Expansions were considered adequate when the

palatal cusp tip of maxillary posterior teeth contacted the buccal cusp tip of mandibular posterior teeth. After the active expansion phase, the appliance was maintained in the oral cavity as a retainer for 6 months. Dental models were obtained immediately pre-expansion (T1) and 6 months after the end of the active expansion when the appliance was removed (T2).

RME group was treated with rapid maxillary expansion using Hyrax expander (Fig. 2). Considering that the participants were in the mixed dentition, appliance anchorage was provided by bands adapted either on maxillary first permanent molars or second deciduous molars, and circumferential clamps bonded to deciduous canines. When second deciduous molars were banded, a lingual extension wire was placed in the partially erupted maxillary first permanent molars. The 11-mm screw (Dentaurum, Ispringen, Germany) was activated two-quarter turn in the morning and two-quarter turn in the evening. The expansion active phase ranged from 7 to 14 days. Expansions were considered adequate when the palatal cusp tip of maxillary posterior teeth contacted the buccal cusp tip of mandibular posterior teeth. After this phase, the appliance was kept as a retainer for 6 months. Similarly to SME group, dental models were obtained immediately pre-expansion (T1) and 6 months after expansion at the occasion of expander removal (T2).

Standardized dental models were scanned using the 3Shape R700 3D© scanner (3Shape A / S, Copenhagen, Denmark). Measurements were performed on the pre and post-expansion maxillary digital dental models using OrthoAnalyzer 3D© (3Shape A/S, Copenhagen, Denmark).

Outcomes (primary and secondary) and any changes after trial commencement

The primary outcomes were the changes in the maxillary dental arch widths (3-3, 4-4, 5-5, 6-6), arch perimeter, arch length, palatal depth and buccolingual inclination of posterior teeth (I3, I5, I6), as summarized in Figures 3, 4 and 5. The secondary outcome was the differential amount of expansion accomplished at canine and molar regions. There were no outcome changes after trial commencement.

Sample size calculation

Calculation of sample size was based on the ability to detect a difference in the intercanine width (one of the primary outcomes) of 1.5 mm with an alpha error of 5%, a power of 80% and a standard deviation of 1.87.[32] Twenty-five participants were required in each group.

Interim analyses and stopping guidelines

Not applicable.

Randomization (random number generation, allocation concealment, implementation)

Computer-generated randomization based in random permuted blocks of 20 patients was accomplished with Stata© Software (StataCorp, College Station, Tex) to ensure equal distribution of participants in the groups. Allocation concealment was achieved with sequentially, numbered, sealed, opaque envelopes containing the expansion modality allocation cards, which were prepared before the trial. One operator was responsible for opening the next envelope in sequence and implementing the randomization process.

Blinding

Blinding of patients and operator regarding the modality of expansion was not possible; however the outcome assessment was blinded because digital dental models were unidentified during analysis.

Statistical analysis (primary and secondary outcomes, subgroup analyses)

One operator (A.C.M.A.) performed all the measurements on the digital dental models and repeated the measures in 30% of the sample at least one month later.

The study error was assessed using Dahlberg's formula[33] and paired *t* test to determine random and systematic errors, respectively.

Normal distribution of variables was verified using Kolmogorov-Smirnov test. Intergroup comparisons for baseline data was performed using Student´s t test. Chi-square test was used for intergroup comparison regarding sex ratio.

Inter-phase changes analysis for both groups was performed using paired *t* test. Intergroup comparisons of primary and secondary outcomes were performed using Student's *t* test.

A statistical significance level of 5% ($p<0.05$) was regarded for all tests and associated 95% confidence intervals (CI) were calculated. All analyses were conducted with Statistica©, version 11 (StatSoft Inc., Tulsa, USA).

RESULTS

Participant flow (include flow diagram, early stopping and time periods)

Eighty-three participants were recruited from September of 2011 to September of 2013; 21 patients (25.30%) were excluded because did not meet the eligibility criteria. Sixty-two patients were randomized in a 1:1 ratio to study groups (SME group, 31; RME group, 31). The trial ended when the sample size allowed a drop-out rate of 20%. Figure 6 shows the participants' flow chart with reasons of losses and exclusions before and after randomization.

Baseline data (include baseline table)

Baseline characteristics showed that patients' initial mean ages were similar in both groups (Table I). Treatment time was significantly greater for SME group compared to RME group (Table I). Most of the patients of both groups were male and no intergroup differences were found for sex distribution (Table I).

Numbers analyzed for each outcome, estimation and precision, subgroup analyses

Five out of thirty-one (16.12%) and six out of thirty-one (19.35%) patients from SME and RME groups, respectively, were lost during enrollment because canines or maxillary deciduous molars have exfoliated and there was no enough dental anchorage to install the appliances. Expanders were installed in 26 patients of SME group and 25 participants of the RME group. One patient from SME group was excluded from the sample because the quad helix appliance was misadjusted. Twenty-five patients for each group were properly analyzed in their original assigned groups. The primary analysis was carried out on an intention-to-treat basis involving all patients randomized after consideration of missing data.

Kolmogorov-Smirnov test showed that the variables studied had normal distribution in the sample, thus parametric statistical tests were used. Intraexaminer reliability was considered very good once our random errors are in accordance with the values found in another study that validated the arch width measurements in digital dental models (Table II).[34] There were no significant systematic errors (Table II). No differences were found between the maxillary dental arch dimensions of SME and RME groups at T1 (Table III).

SME and RME caused a significant increase of arch widths and arch perimeter (Tables IV and V). RME produced a significant decrease of arch length and palatal depth (Table V). Buccal tooth tip was significant only for maxillary deciduous canines in both groups (Tables IV and V). No statistical differences were observed between SME and RME changes (Table VI).

Differently from the Hyrax expander, the quad helix appliance produced a differential expansion with a greater increase of intercanine width compared to the intermolar width (Table VII).

Harms

No serious harm was observed other than variable pressure sensations around the teeth, under the eyes and at the nasal area reported during treatment by participants of RME group. However, these symptoms disappeared rapidly with no major discomfort.

DISCUSSION

Main findings in the context of the existing evidence, interpretation

Dentoskeletal effects of slow and rapid maxillary expansions in growing patients without craniofacial anomalies have been studied for decades.[10-17] However there is a few number of clinical studies that analyzed the effects of SME and RME in patients with cleft lip and palate.[9,18-20,22,35] There are differences in the expansion outcomes between patients with and without the integrity of the palate.[14,22,36,37]

Our study sample was very homogeneous regarding the type of oral cleft, initial age and sex (Table I). The lack of statistical significance for intergroup comparison at T1 suggests that patients of both groups had no differences in the initial maxillary dental arch dimensions. Additionally, these findings confirm the sample homogeneity and ensure the effectiveness of randomization and allocation of the participants.

The significant greater treatment time for SME compared to RME occurred for obvious reasons related to the activation protocol of each type of expander. The difference between RME and SME groups was associated to the difference in the active expansion time considering that the retention time was the same for both groups. RME corrected the arch constriction from 7 to 14 days consequent to the high speed of activation.[14] On the other hand, SME took at least 2 months to correct the arch constriction due to the light forces delivered.[24] No previous study has compared the treatment time of SME and RME in patients with cleft lip and palate. In noncleft patients, Akkaya et al. also found a greater treatment time for SME compared to RME.[38]

In the SME group, the maxillary arch widths showed an increase of 3.98 to 6.89mm, causing a mean increase of 7.97 mm in the arch perimeter (Table IV). These transversal changes are in accordance with a recent study in patients with complete cleft lip and palate that found similar arch widths increases after SME with quad helix appliance.[9] In noncleft patients, Wong et al. found intercanine and intermolar width changes of 4.56 and 4.32 mm, respectively, producing an increase of the arch perimeter of 3.27 mm after SME.[39] The greater increase of the intercanine width and arch perimeter observed in our study may be associated to the severe

constriction of the anterior region in patients with BCLP that is commonly more pronounced compared to noncleft individuals.[6,7]

The arch length in the SME group did not change after expansion (Table IV). However, in contrast, a recent study found an increase of the arch length of 0.32 mm with SME in noncleft patients.[39] The differences between the findings in patients with and without oral clefts may be related to a small posterior displacement of premaxilla toward the alveolar cleft, after the expansion in the last.[40] While the distal rotation of maxillary first permanent molars contributes for the arch length increase in noncleft individuals, in patients with BCLP, the posterior settlement of premaxilla on the widened alveolar cleft compensate the change, resulting in a numerical stability of the arch length.[41]

The palatal depth showed no significant changes after SME (Table IV). A reduction of palatal depth would be expected as the posterior dentoalveolar ridges bend buccally with SME.[42] However, a very slight posterior tooth inclination occurred in the SME group (Table IV). Additionally, a possible extrusion of posterior teeth during expansion could have hypothetically compensated the reduction tendency. On the other hand, Ciambotti et al. observed a stability of palatal depth after expansion with nickel-titanium slow palatal appliance in noncleft patients.[42]

After SME, the buccal inclination of deciduous canines, second deciduous molars and first permanent molars increased 4.13, 0.12 and 0.42 degrees, respectively, (Table IV). Significant differences were found only for the deciduous canines possibly because they are single-rooted teeth and expansion was greater at the anterior region of the maxillary dental arch (Table IV). Additionally, in our study, anchorage posterior teeth varied between deciduous second molars and first permanent molars what might have influenced the final results of posterior teeth inclination. All previous studies restricted the assessment of inclination to posterior teeth and did not include the maxillary canines. A previous study found a significant increase of the buccal inclination of first permanent molars of 7 degrees using quad helix appliance in patients with unilateral cleft lip and palate.[9] In noncleft patients, Wong et al. assessed only the buccolingual inclination changes of first permanent molars and found an increase of buccal tipping of 4 degrees after SME.[39]

In the RME group, the arch widths increased significantly from 3.53 to 6 mm causing a significant increase in the arch perimeter of 5.22 mm (Table V). The findings related to the transversal increase are in accordance with previous studies in

individuals with CLP.[9,19,35] No study assessed the arch perimeter using rapid maxillary expanders in cleft patients. In noncleft individuals, Akkaya et al. found intercanine and intermolar widths increase of 6.35 and 9.05 mm, respectively, producing an arch perimeter increase of 6.85 mm after RME with Hyrax expander.[38] The arch perimeter changes are highly predicted from changes in posterior teeth widths.[38,43,44] A classical study performed regression analyses and found that changes in arch perimeter are approximately 0.7 times the premolar expansion.[43]

The arch length showed a significant decrease of 0.99 mm after RME (Table V). This statistical significance may have occurred due to a posterior displacement of pre-maxilla after the widening of the alveolar cleft consequent to the orthopedic effect. In patients without cleft, the arch length also shows a reduction after expansion.[29,44,45] The decrease of arch length observed in noncleft patients is associated to a lingual inclination of maxillary central incisors that occur together with the spontaneous closure of maxillary interincisor diastema.[45] During RME passive period, maxillary central incisors move mesial and lingually closing the central diastema.[46]

The slight and significant decrease of the palatal depth observed for the RME group (Table V) may be associated to the lowering of the palatal shelves classically described in the literature.[23,47]. No previous study evaluated the palatal depth after expansion in patients with cleft lip and palate and this deficiency may be due to the methodological difficulties with conventional dental models. The digital dental models permit to measure other parameters not evaluated before with conventional methodologies, including palatal depth, palatal area and volume.[48,49]

In our study, RME caused a significant buccal tip only of the canines (Table V). No other study has assessed the buccolingual inclination of deciduous canines in cleft patients. The absence of significant buccal tip of molars is in agreement with a recent study performed in unilateral CLP using cone-beam computed tomography that did not find tooth inclination of minor segment posterior teeth after RME.[35] In noncleft patients, buccal inclination of posterior teeth was consistently found.[15,27,28,42,43] Hypothetically, noncleft patients has a slighter greater resistance associated to the midpalatal suture that favor posterior teeth buccal inclination.[27] Additionally, the variation in the teeth that received bands in our sample may have influenced the results because minimized the mean buccal inclination of deciduous and permanent molars.

Intergroup comparison of maxillary dental arch changes showed no statistically significant differences for all evaluated parameters (Table VI). In other words, no differences were observed for the primary outcomes of slow and rapid maxillary expansions in patients with BCLP. Similarly, a recent study found no significant differences between SME and RME in patients with either unilateral or bilateral CLP, stating that slow maxillary expansion was a reasonable alternative to rapid maxillary expansion in patients with oral clefts.[9] On the other hand, previous studies found that, in noncleft patients, SME produces greater buccal inclination of teeth and smaller orthopedic effects compared to RME.[23,38] The absence of differences between SME and RME found in the current study may be explained by the absence of midpalatal suture in patients with BCLP.[50,51] The absence of intermaxillary suture may decrease the resistance to the lateral movement of the maxillary segments and may produce orthopedic effects even when lighter forces of slow expansion are delivered.[24,52]

Finally, the last parameter for comparing SME and RME was the capability of producing differential expansion. Quad helix appliance caused a greater expansion in the intercanine region compared to the intermolar region (Table VII). This finding is in accordance with the results of a recent study that found a differential expansion of 4.15 mm using quad helix expander in patients with unilateral and bilateral CLP.[9] This greater expansion in the anterior region than in the posterior region of the maxillary dental arch is frequently necessary in patients with BCLP because they have greater constrictions of intercanine width compared to intermolar width.[8] Differently from SME, RME did not cause differential expansion (Table VII). This finding is in accordance with the results of other study that found a non-significant differential expansion with Hyrax expander in patients with CLP.[9] In noncleft patients, Bratu et al. observed a non-significant differential expansion between inter-first premolars and intermolar expansion, after RME.[53] The tendency to promote similar intercanine and intermolar widths changes in cleft and non-cleft patients may be related to the fact of Hyrax presents a screw with parallel opening.[54] Very recently, a new RME expander was described in the literature with the goal of producing differential expansions.[55] This appliance differs from the conventional Hyrax expander due to the presence of two expansion screws and the possibility of promoting an anteriorly divergent expansion.[55]

No important harm was caused to the participants of this study. The benefits and collateral effects of both type of expander were already known from previous literature in individuals without oral clefts.

Considering that no significant differences were found between the dentoalveolar effects of SME and RME, both modalities of expansion seem to be equally effective for the treatment of maxillary dental arch constriction in patients with BCLP. Although the quad helix appliance is considered an effective and simple expander[56] with a favorable cost-benefit[56-59], treatment time was slight greater than that observed for the Hyrax expander.

Limitations

The limitation of this study was the variation in posterior anchorage teeth. In SME group, 9 (36%) patients had maxillary second deciduous molars banded while 16 (64%) patients had the bands adapted on the maxillary first permanent molars. In RME group, this values corresponded to 13 (52%) and 12 (48%) patients, respectively. These limitations should have influenced the outcomes observed for molar buccal inclination. However, this problem could not be avoided in a study on an intention-to-treat basis. In the mixed dentition, some patients still had the distal aspect of permanent first molar covered by gingiva while other patients had advanced root resorption in the second deciduous molars.

Dental model analysis does not permit the estimation of the orthopedic effects produced by each type of expander. Future studies should compare the bone changes of SME and RME by means of CBCT.

Generalizability

The generalizability of these results might be limited to patients with BCLP in the mixed dentition because expansion effects differ according to age and presence of midpalatal suture. Additionally, these results cannot be generalized to different type of expanders or to the same expanders used with different activation protocols.

CONCLUSIONS

- The null hypothesis was not rejected. Slow and rapid maxillary expansions seem to cause similar maxillary dental arch changes in patients with bilateral complete cleft lip and palate;
- Differently from the conventional Hyrax expander, quad helix appliance can perform a differential expansion in maxillary dental arch. On the other hand, SME demands a greater treatment time compared to RME.

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FIGURE CAPTIONS

Fig 1. Pre and post-expansion digital dental models of three patients of slow maxillary expansion group.

Fig 2. Pre and post-expansion digital dental models of three patients of rapid maxillary expansion group.

Fig 3. Arch widths considered the distances 3-3 (intercanine distance at the level of the gingival margin), 4-4 (distance between first deciduous molars), 5-5 (distance between second deciduous molars) and 6-6 (inter-first permanent molar distance). Arch perimeter was the sum of P3-6, P1-3, P1-3'and P3-6'.

Fig 4. Arch length (AL) was measured in the horizontal plane from the mesial aspect of first permanent molars to the point between the maxillary central incisors. The palatal depth (PD) was measured from a line passing through the mesial gingival papilla of first permanent molars to the deepest point on the palate, perpendicularly to the arch length.

Fig 5. Buccolingual inclination was measured considering the angle between the occlusal plane and a tangent line passing through the most prominent point on the buccal aspect of the clinical crown of deciduous canines (I3), second deciduous molars (I5) and first permanent molars (I6). The occlusal plane was built considering three occlusal points: buccal cusp tip of maxillary first permanent molars on both sides and the most mesial point of the incisal edge of the right maxillary central incisor.

Fig 6. CONSORT diagram showing patient flow during the trial.

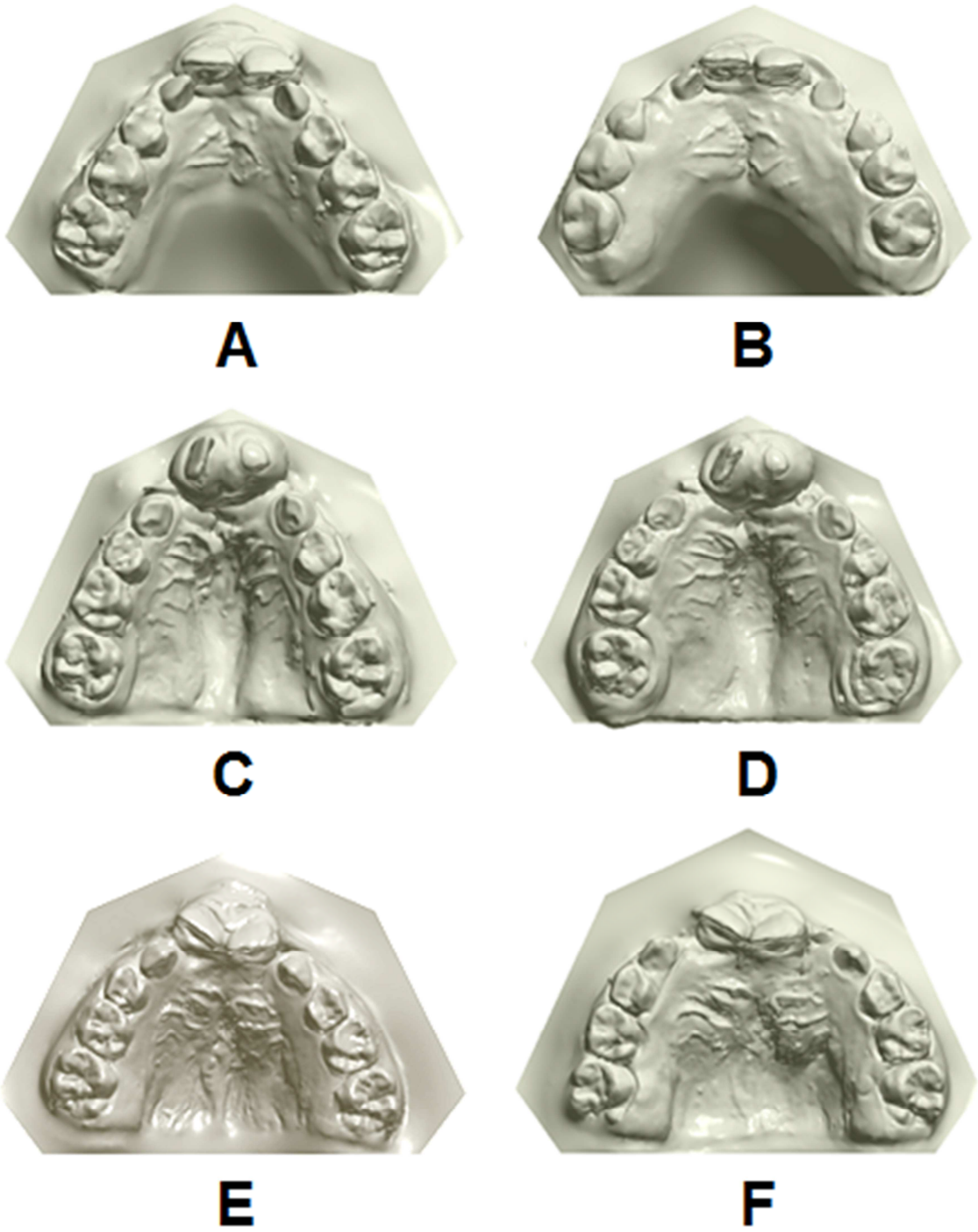

Fig 1

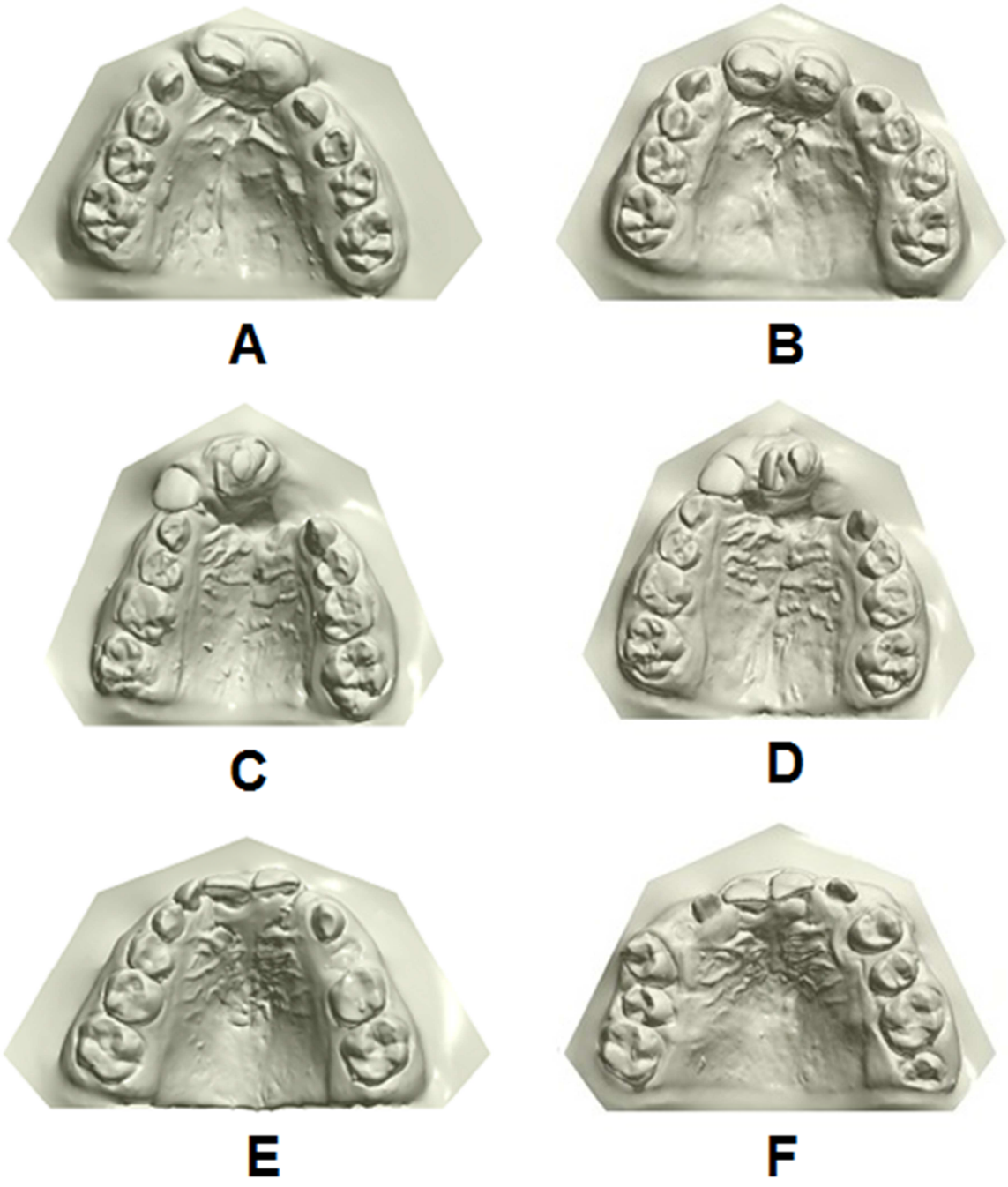

Fig 2

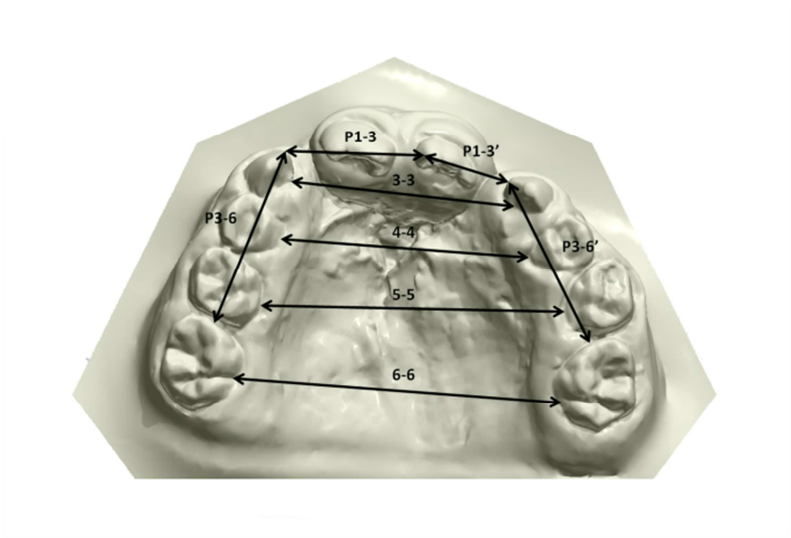

Fig 3

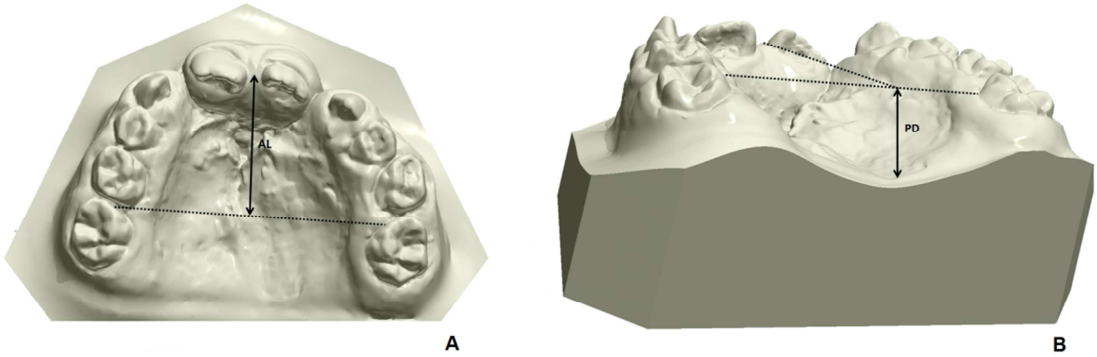

Fig 4

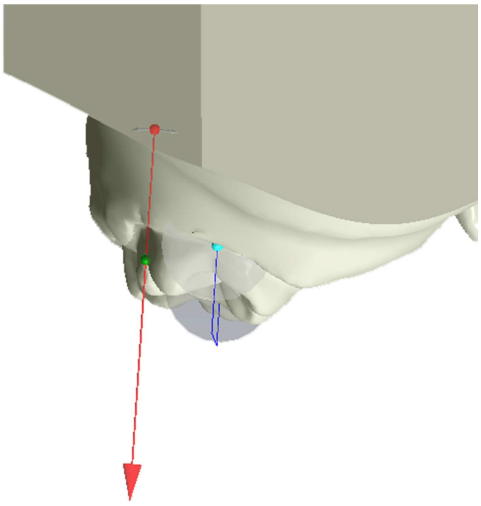

Fig 5

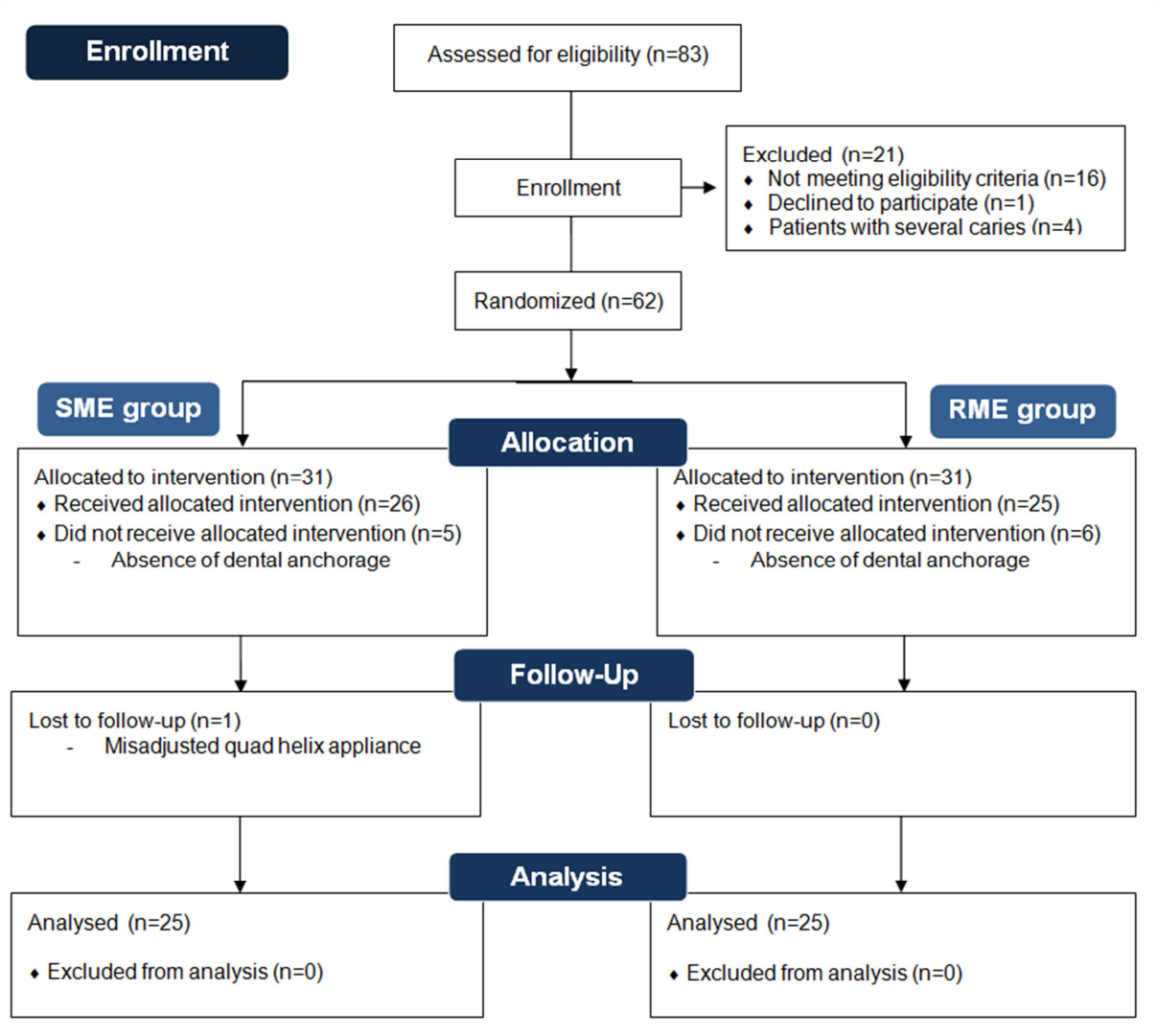
Enrollment
Assessed for eligibility (n=83)
Enrollment
Excluded (n=21)
Not meeting eligibility criteria (n=16)
Declined to participate (n=1)
Patients with several caries (n=4)
Randomized (n=62)
SME group
Allocation
RME group
Allocated to intervention (n=31)
Received allocated intervention (n=26)
Did not receive allocated intervention (n=5)
- Absence of dental anchorage
Allocated to intervention (n=31)
Received allocated intervention (n=25)
Did not receive allocated intervention (n=6)
- Absence of dental anchorage
Follow-Up
Lost to follow-up (n=1)
- Misadjusted quad helix appliance
Lost to follow-up (n=0)
Analysis
Analysed (n=25)
Excluded from analysis (n=0)
Analysed (n=25)
Excluded from analysis (n=0)

Fig 6

Table I. Intergroup comparisons for age, treatment time and sex ratio (Student's *t* test and Chi-square test)

Variable		SME group (n=25)		RME group (n=25)		
		Mean	**SD**	**Mean**	**SD**	**p**
Initial age (years)		8.85	0.99	8.95	1.35	0.767
Treatment time (months)		11.00	4.58	7.20	3.51	0.002*
Sex	**Male**	19		18		0.851
	Female	6		7		

* - Statistically significant ($p<0.05$).

SD – Standard deviation.

Table II. Random and systematic errors of the measurements performed on the digital dental models (Dahlberg's formula and paired *t* test)

	1st measurement (n=15)		2nd measurement (n=15)			
Variable	**Mean**	**SD**	**Mean**	**SD**	**Error**	**p**
3-3	20.57	6.19	20.62	6.04	0.21	0.554
4-4	24.77	5.10	25.18	5.66	0.72	0.132
5-5	31.05	4.78	31.09	4.92	0.23	0.663
6-6	37.22	5.54	37.05	5.19	0.42	0.324
Arch perimeter	64.51	15.58	64.18	16.32	0.74	0.773
Arch length	23.30	3.44	23.38	3.67	0.45	0.629
Palatal depth	8.10	2.68	7.81	2.55	0.42	0.072
I3	74.41	8.22	75.08	8.28	0.52	0.291
I5	78.35	4.96	78.36	4.66	0.34	0.934
I6	80.26	4.12	80.02	4.05	0.42	0.132

* - Statistically significant ($p<0.05$).

Table III. Intergroup comparability at T1 (Student's *t* test)

	SME group (n=25)			RME group (n=25)			
Variable	**Mean**	**SD**	**95% CI**	**Mean**	**SD**	**95% CI**	**p**
3-3	19.53	3.96	3.09 - 5.51	18.90	4.44	3.37 - 6.48	0.745
4-4	24.53	4.35	3.33 - 6.28	24.14	3.27	2.48 - 4.77	0.686
5-5	30.08	3.21	2.45 - 4.63	29.68	3.53	2.72 - 5.05	0.656
6-6	34.42	3.94	3.00 - 5.76	35.68	3.95	3.06 - 5.61	0.303
Arch perimeter	68.54	8.27	6.46 - 11.51	69.73	7.55	5.62 - 11.50	0.864
Arch length	25.01	3.77	2.94 - 5.25	24.81	3.68	2.83 - 5.26	0.984
Palatal depth	9.30	2.65	2.07 - 3.68	8.53	2.46	1.92 - 3.42	0.295
I3	77.08	6.99	5.84 - 8.72	74.48	6.72	5.56 - 8.49	0.086
I5	78.59	6.34	5.22 - 8.09	77.15	5.82	4.78 - 7.45	0.283
I6	80.12	5.87	4.83 - 7.49	79.15	5.44	4.51 - 6.85	0.425

- - Statistically significant ($p<0.05$).

Table IV. Inter-phase comparison for SME group (Paired *t* test)

Variable	Pre-expansion			Post-expansion			Change			
	Mean	SD	95% CI	Mean	SD	95% CI	Mean	SD	95% CI	p
3-3	19.53	3.96	3.09 - 5.51	26.11	4.00	3.12 - 5.57	6.58	3.58	5.10 - 8.06	<0.001*
4-4	24.53	4.35	3.33 - 6.28	31.42	4.07	3.11 - 5.88	6.89	3.47	5.31 - 8.47	<0.001*
5-5	30.08	3.21	2.45 - 4.63	35.34	3.42	2.62 - 4.95	5.26	2.63	4.06 - 6.46	<0.001*
6-6	34.42	3.94	3.00 - 5.76	38.40	3.36	2.56 - 4.91	3.98	2.41	2.85 - 5.11	<0.001*
Arch perimeter	68.54	8.27	6.46 - 11.51	76.52	6.85	5.35 - 9.53	7.97	6.73	5.19 - 10.76	<0.001*
Arch length	25.01	3.77	2.94 - 5.25	24.66	4.19	3.27 - 5.83	-0.35	1.35	-0.91 - 0.20	0.205
Palatal depth	9.30	2.65	2.07 - 3.68	8.65	2.88	2.25 - 4.01	-0.65	1.72	-1.36 - 0.06	0.071
I3	77.08	6.99	5.84 - 8.72	81.10	5.79	4.82 - 7.25	4.13	4.37	2.86 - 5.40	<0.001*
I5	78.59	6.34	5.22 - 8.09	78.76	7.58	6.20 - 9.78	0.12	12.17	3.69 - 4.19	0.900
I6	80.12	5.87	4.83 - 7.49	80.54	5.38	4.40 - 6.68	0.42	6.53	1.61 - 2.45	0.877

* - Statistically significant ($p<0.05$).

Table V. Inter-phase comparison for RME group (Paired *t* test)

	Pre-expansion			Post-expansion			Change			
Variable	**Mean**	**SD**	**95% CI**	**Mean**	**SD**	**95% CI**	**Mean**	**SD**	**95% CI**	**P**
3-3	18.90	4.44	3.37 - 6.48	24.01	4.02	3.06 - 5.88	5.11	2.74	3.82 - 6.39	<0.001*
4-4	24.14	3.27	2.48 - 4.77	30.15	3.36	2.55 - 4.91	6.00	3.99	4.13 - 7.87	<0.001*
5-5	29.68	3.53	2.72 - 5.05	35.14	2.99	2.30 - 4.27	5.46	2.89	4.18 - 6.75	<0.001*
6-6	35.68	3.95	3.06 - 5.61	39.21	4.36	3.37 - 6.17	3.53	2.73	2.35 - 4.71	<0.001*
Arch perimeter	69.73	7.55	5.62 - 11.50	74.96	6.57	4.90 - 10.01	5.22	5.09	2.60 - 7.85	<0.001*
Arch length	24.81	3.68	2.83 - 5.26	23.81	3.27	2.51 - 4.67	-0.99	2.04	-1.90 - -0.09	0.033
Palatal depth	8.53	2.46	1.92 - 3.42	7.58	2.78	2.17 - 3.87	-0.95	2.23	-1.87 - -0.03	0.043
I3	74.48	6.72	5.56 - 8.49	78.34	6.89	5.69 - 8.73	3.74	4.59	2.33 - 5.16	<0.001*
I5	77.15	5.82	4.78 - 7.45	79.58	6.12	4.78 - 7.45	2.16	6.63	0.01 - 4.34	0.061
I6	78.60	5.44	4.51 - 6.85	79.15	5.70	1.55 - 2.65	0.54	7.08	1.55 - 2.65	0.603

* - Statistically significant ($p<0.05$).

Table VI. Intergroup comparisons for expansion changes (Student's *t* test)

	SME group			RME group			
Variable	**Change**	**SD**	**95% CI**	**Change**	**SD**	**95% CI**	**p**
3-3	6.58	3.58	5.10 - 8.06	5.11	2.74	3.82 - 6.39	0.137
4-4	6.89	3.47	5.31 - 8.47	6.00	3.99	4.13 - 7.87	0.453
5-5	5.26	2.63	4.06 - 6.46	5.46	2.89	4.18 - 6.75	0.755
6-6	3.98	2.41	2.85 - 5.11	3.53	2.73	2.35 - 4.71	0.572
Arch perimeter	7.97	6.73	5.19 - 10.76	5.22	5.09	2.60 - 7.85	0.162
Arch length	0.35	-1.35	-0.91 - 0.20	-0.99	2.04	-1.90 - -0.09	0.205
Palatal depth	0.65	-1.72	-1.36 - 0.06	-0.95	2.23	-1.87 - -0.03	0.596
I3	4.13	4.37	2.86 - 5.40	3.74	4.59	2.33 - 5.16	0.679
I5	0.12	12.17	3.69 - 4.19	2.16	6.63	0.01 - 4.34	0.394
I6	0.42	6.53	1.61 - 2.45	0.54	7.08	1.55 - 2.65	0.507

* - Statistically significant ($p<0.05$).

Table VII. Comparison between the changes in intercanine and intermolar widths observed in SME and RME groups (Student's *t* test)

	C13-23			C16-26			
Variable	**Change**	**SD**	**95% CI**	**Change**	**SD**	**95% CI**	**p**
SME group	6.58	3.58	5.10 - 8.06	3.98	2.41	2.85 - 5.11	0.008*
RME group	5.11	2.74	3.82 - 6.39	3.53	2.73	2.35 - 4.71	0.067

* - Statistically significant ($p<0.05$).

3 Discussion

3 DISCUSSION

Randomized clinical trial is a modality of study with high level of scientific evidence, because rigorous criteria to control methodological bias are used, such as the specification of eligibility criteria, sample size calculation, description of blinding, method error analysis, and detailed description of the number of participants in the sample lost during the follow-up time (MOHER; SCHULZ; ALTMAN, 2001).

Only one study of the literature, performed a randomized clinical trial comparing the dentoalveolar effects of SME and RME in patients with CLP (VASANT; MENON; KANNAN, 2009). However, this aforementioned study has some methodological limitations, such as the inclusion of patients with unilateral and bilateral CLP in the same group, and the performing of manual measurements difficult to be reproduced and without validation. Additionally, this study shows moderate risk of bias, because there is a lack of sample size calculation, power test, method error analysis, and description of randomization, blinding and recruitment of the participants.

A systematic review recently published in the literature (PLINT et al., 2006) observed an improvement in the scientific quality of randomized clinical trials that were developed based on the "CONSORT checklist", available on the "CONSORT group" website. Therefore, in order to minimize the risk of bias and increase the reliability of our results, the current study was developed based on the "CONSORT checklist" and the "CONSORT explanation and elaboration: updated guidelines for reporting parallel group randomized trials" (SCHULZ; ALTMAN; MOHER, 2010). These two scientific publications were written aiming to guide researchers in the development of randomized clinical trial with a high scientific rigor.

Regarding the methodology of the current study, all the variables were assessed using measurements performed on digital dental models. The three-dimensional analysis of dental models started with the digital revolution occurred in the 90s, and nowadays, it has been widely used in the development of Orthodontic researches because it enables the demarcation of points, the drawing of lines and the performing of linear and angular measurements (RHEUDE et al., 2005; WHETTEN et al., 2006). Therefore, the three-dimensional analyses of digital dental

models allow assess with high accuracy and reproducibility variables that are difficult to be measured manually in conventional dental models, such as the palatal depth, palatal volume, and inclination and angulations of teeth (BRAUMANN et al., 2002; SANTORO et al., 2003; ZILBERMAN; HUGGARE; PARIKAKIS, 2003; QUIMBY et al., 2004; ASQUITH; GILLGRASS; MOSSEY, 2007; OKUNAMI et al., 2007; DALSTRA; MELSEN, 2009; KREY; BORNGEN; DANNHAUER, 2009). Measuring these variables is possible due to the vertical, horizontal, and transverse virtual cross sections that can be performed in the three-dimensional models using specific computer software (BRAUMANN et al., 2002; KREY; BORNGEN; DANNHAUER, 2009).

Based on the results of the current study, it is suggested to conduct more studies evaluating and comparing three-dimensionally the shape of maxillary dental arch and the palatal volume of patients with BCLP before and after SME and RME. Another suggestion is performing the overlap of digital dental models obtained at two different times. This procedure may allow the visualization of dentoalveolar changes caused by treatment. The assessment of these other variables may complement the findings of the current study and may contribute to a greater understanding about the dentoalveolar effects of slow and rapid maxillary expansions in patients with bilateral complete cleft lip and palate.

4 Final Considerations

4 FINAL CONSIDERATIONS

The absence of differences between the dentoalveolar effects of slow and rapid maxillary expansions in patients with bilateral complete cleft lip and palate suggests that both expansion modalities can be properly used in the treatment of patients with BCLP. Additionally, both slow and rapid maxillary expanders used in the current study showed clinically relevant advantages and disadvantages. Quad helix appliance promoted a differential expansion of the intercanine width compared to the intermolar width in maxillary dental arch, while Hyrax expander does not. Therefore, quad helix can be considered a reasonable alternative appliance to Hyrax. However SME using quad helix appliance was associated to a greater treatment time compared to RME using Hyrax expander. These parameters must be considered by Orthodontists for the achievement of an effective treatment in patients with BCLP.

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Annexes

ANNEX A – Ethics Committee approval, protocol number 349169 (front).

HOSPITAL DE REABILITAÇÃO DE ANOMALIAS CRANIOFACIAIS DA USP

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Efeitos da expansão rápida e lenta da maxila em pacientes com fissura labiopalatina completa e bilateral: avaliação por meio de modelos digitais

Pesquisador: Arthur César de Medeiros Alves

Área Temática:

Versão: 2

CAAE: 16467113.0.0000.5441

Instituição Proponente: Hospital de Reabilitação de Anomalias Craniofaciais da USP

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 349.169

Data da Relatoria: 30/07/2013

Apresentação do Projeto:

Pesquisa de Intervenção/Experimental com finalidade de dissertação com avaliação de 60 pares de modelos digitalizados de pacientes com fissuras labiopalatinas completas e bilaterais e atresia do arco dentário superior tratados com aparelho de expansão.

Objetivo da Pesquisa:

Comparar os efeitos oclusais da expansão rápida da maxila e da expansão lenta maxilar, em pacientes com fissura labiopalatina completa e bilateral, por meio de modelos digitais tridimensionais.

Avaliação dos Riscos e Benefícios:

Considerando que essa pesquisa consistirá na avaliação de modelos de gesso convencionais que serão digitalizados para que sejam realizadas mensurações por meio de programas específicos de computador, pode-se afirmar que a realização desse estudo não trará riscos diretos aos pacientes. Os benefícios oriundos com essa pesquisa consistem no fato de que os modelos digitais tridimensionais obtidos poderão ser arquivados no banco de dados dos computadores do Hospital de Reabilitação de Anomalias Craniofaciais da USP, como parte da documentação dos pacientes. Como o profissional poderá ter acesso mais fácil dos modelos digitais através do computador, os pacientes poderão ser beneficiados com um tempo de consulta menor, além de que, as

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ANNEX A – Ethics Committee approval, protocol number 349169 (verso).

HOSPITAL DE REABILITAÇÃO DE ANOMALIAS CRANIOFACIAIS DA USP

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explicações dos seus tratamentos poderão ser feitas através da visualização do modelo na tela do computador, podendo-se manipular o modelo digital em várias posições e tamanhos, para um melhor entendimento pelo paciente e seu responsável.

Comentários e Considerações sobre a Pesquisa:

A amostra deste estudo retrospectivo consistirá de 60 pares de modelos de gesso digitalizados de pacientes com fissuras labiopalatinas completas e bilaterais, do Hospital de Reabilitação de Anomalias Craniofaciais/USP. Os modelos de gesso dos pacientes serão divididos em dois grupos de estudo: Grupo I- Composto por 30 pares de modelos de pacientes cujo procedimento de expansão foi Hyrax. Grupo II- Composto por 30 pares de modelos de pacientes cujo procedimento de expansão foi realizado com aparelho quadri-hélice. Após a digitalização, os modelos iniciais e pós-expansão do arco superior serão mensurados pelo método digital no software OrthoAnalyzerTM 3D (3Shape A/S, Copenhagen, Dinamarca).

Considerações sobre os Termos de apresentação obrigatória:

Todos os termos foram adequados às normas do CEP.

Recomendações:

Conclusões ou Pendências e Lista de Inadequações:

Recomendo a aprovação do projeto após efetuadas as alterações solicitadas.

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

Considerações Finais a critério do CEP:

O Colegiado acatou o parecer do relator em seus aspectos éticos e metodológicos de acordo com as Diretrizes estabelecidas na Resolução 466/12 e complementares do Conselho Nacional de Saúde. Ressaltamos que, conforme a Resolução CNS 466/12, o pesquisador é responsável por "desenvolver o projeto conforme delineado" e por informar ao CEP as emendas, ou seja, "todos os fatos relevantes que alterem o curso normal dos estudos por ele aprovados e, especificamente, nas pesquisas na área da saúde, dos efeitos adversos e da superioridade significativa de uma intervenção sobre outra ou outras comparativas" (alterações que envolva métodos, critérios éticos, mudança de pesquisadores/entrevistadores e instrumental), tais emendas devem ser entregues na Seção de Apoio a Pesquisa do SVAPEPE, bem como anexadas na Plataforma Brasil. O CEP avaliará e emitirá o parecer das emendas.

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ANNEX A – Ethics Committee approval, protocol number 349169 (front).

HOSPITAL DE REABILITAÇÃO DE ANOMALIAS CRANIOFACIAIS DA USP

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O pesquisador também fica responsável pela entrega dos relatórios semestrais e final, bem como notifica-los pela Plataforma Brasil.
Informamos que após o recebimento do trabalho concluído, este Comitê enviará o parecer final para publicação do trabalho.

BAURU, 05 de Agosto de 2013

Assinador por:
Marcia Ribeiro Gomide
(Coordenador)

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ANNEX B – Informed consent.

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Pelo presente instrumento que atende às exigências legais, o Sr (a) _____ , portador (a) da célula de identidade _____, responsável pelo (a) paciente *_____, após leitura minuciosa deste documento, devidamente explicado pelos profissionais em seus míimos detalhes, ciente dos serviços e procedimentos aos quais será submetido, não restando quaisquer duvidas a respeito do lido e explicado, firma seu CONSENTIMENTO LIVRE E ESCLARECIDO concordando em participar da pesquisa: **" Efeitos suscitados pela expansão rápida e lenta da maxila em pacientes com fissura transforame incisivo bilateral: avaliação por meio da Tomografia Computadorizada *Cone-beam* e por modelos dentários digitais."**, realizada pela Drª Araci Malagodi de Almeida, nº do Conselho: CROSP 26.373, que tem como objetivo: avaliar e comparar os efeitos dentoesqueléticos da expansão rápida da maxila e da expansão lenta maxilar, por meio da tomografia computadorizada *cone-beam* (TCCB) e por modelos dentários em pacientes com fissura transforame incisivo bilateral. Para esta finalidade, serão realizados uma moldagem e um exame de tomografia computadorizada de feixe cônico antes da instalação do aparelho expansor do palato e após a remoção do mesmo. O tempo previsto para tomada da moldagem equivale à aproximadamente 20 minutos, e a realização do exame de tomografia computadorizada de feixe cônico equivale a 30 minutos. Esses exames serão realizados no HRAC-USP, no dia da consulta inicial para planejamento ortodôntico ou no dia programado para instalação do aparelho expansor, no Setor de Odontologia (área de Ortodontia), assim como na consulta para a remoção do expansor e substituição pelo aparelho de contenção fixa. É importante mencionar que o exame de tomografia computadorizada de feixe cônico substituirá o conjunto de exames radiográficos extra e intrabucais, requisitados antes do tratamento ortodôntico e previamente à cirurgia de enxerto ósseo alveolar. O benefício da investigação deste tipo consiste em indicar o melhor tipo de aparelho para expansão maxilar, de acordo com cada caso em particular.
"Caso o sujeito da pesquisa queira apresentar reclamações em relação à sua participação na pesquisa, poderá entrar em contato com o Comitê de Ética em Pesquisa em Seres Humanos do HRAC-USP pelo endereço Rua Silvio Marchione, 3-20 no Serviço de Apoio ao Ensino, Pesquisa e Extensão ou pelo telefone (14) 3235-8421".

Fica claro que o sujeito da pesquisa ou seu representante legal pode, a qualquer momento, retirar seu CONSENTIMENTO LIVRE E ESCLARECIDO e deixar de participar desta pesquisa, ciente de que todas as informações prestadas tornar-se-ão confidenciais e guardadas por força de sigilo profissional (Art.9°. do Código de Ética em Odontologia).

Por estarem de acordo assinam o presente termo.

Bauru-SP, _____ de _____ de _____.

_____ _____

Assinatura do Sujeito da Pesquisa ou responsável **Assinatura da Pesquisa Responsável**

* A SER PREENCHIDO, SE O SUJEITO DA PESQUISA NÃO FOR O PACIENTE.

Nome da Pesquisadora Responsável:
Araci Malagodi de Almeida
Endereço Institucional: Rua Sílvio Marchione, 3-20
Cidade: Bauru Estado: São Paulo CEP: 17.012-900
Telefone: 14 3235-8000 (ramal 8146) e-mail: amalagodi@yahoo.com.br

ANEXO C – Informed consent.

FORMULÁRIO DE CONSENTIMENTO INFORMADO

Permissão para uso de imagem para fins científicos

Eu, _____ , brasileiro (a), residente no endereço _____, na cidade de _____, portador (a) da cédula de identidade _____, responsável pelo (a) paciente _____, permito as Drs. Araci Malagodi de Almeida e Daniela Gamba Garib Carreira o uso e publicação de minhas imagens fotográficas para fins científicos. Estou ciente de que não serei remunerado (a) pelo uso destas imagens.

Entendo que poderei ser reconhecido (a) por terceiros e que minhas fotografias e/ou tomografias poderão ser publicadas na internet e serem acessadas pelo público em geral, embora haja sigilo quanto às informações pessoais. Os profissionais citados acima e/ou os responsáveis pelo uso das imagens não poderão ser responsabilizados pela eventual utilização inadequada das mesmas. As imagens fotográficas serão somente do terço inferior da face sem que apareçam os olhos.

Estou ciente de que, caso não aceite assinar este termo, receberei dos profissionais acima a mesma qualidade de atendimento e tratamento.

Bauru-SP, _____de _____ de 20 _____.

Assinatura: _____

Nome do paciente: _____

Referência: www.indexaonline.com.br/indexaonline/pt/revistas/arquivos/form.pdf

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	1
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	1 - 2
	2b	Specific objectives or hypotheses	2
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	2
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	2
Participants	4a	Eligibility criteria for participants	2 - 3
	4b	Settings and locations where the data were collected	2
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	3
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	3
	6b	Any changes to trial outcomes after the trial commenced, with reasons	3
Sample size	7a	How sample size was determined	4
	7b	When applicable, explanation of any interim analyses and stopping guidelines	4
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	4
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	4
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	4
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	4
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those	4

		assessing outcomes) and how	4
	11b	If relevant, description of the similarity of interventions	4
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	4
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	4
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	4 and 18
	13b	For each group, losses and exclusions after randomisation, together with reasons	4
Recruitment	14a	Dates defining the periods of recruitment and follow-up	4
	14b	Why the trial ended or was stopped	5 and 19
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	5 and 18
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	5, 21-25
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	5, 21-25
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	5, 21-25
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	5
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	8
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	8
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	5-8
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	1
Other Information			
Registration	23	Registration number and name of trial registry	1
Protocol	24	Where the full trial protocol can be accessed, if available	1
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

ANNEX E – Guidelines for AJO-DO submissions: Randomized Clinical Trials (Front).

Guidelines for AJO-DO submissions: Randomized Clinical Trials
January 2014

Complete and transparent reporting allows for accurate assessment of the quality of trial and correct interpretation of the trial results. Complete and accurate reporting facilitates identification of trials and easy data extraction for inclusion of the trial in future systematic reviews.
The CONSORT reporting guidelines are provided to facilitate accurate, complete, and transparent reporting of randomized clinical trials (RCTs) and best use of research.

New submissions to the *AJO-DO* reporting the results of RCTs will be screened for compliance with the CONSORT (consolidated standards of reporting trials) guidelines. The updated 2010 CONSORT statement includes 25 specific items related to key report areas, including the title, abstract, methods, results, and discussion, to help authors prepare clinical trial reports.

1. Visit the CONSORT website to review the CONSORT 2010 explanation and elaboration document for parallel trials and the CONSORT for abstracts. If relevant, also read the CONSORT extensions for cluster randomized trials, non-inferiority and equivalence trials, non-pharmacological treatments, and pragmatic trials. Additional extensions are forthcoming, so always refer to the website. Study the CONSORT 2010 explanation and elaboration document and its extensions (if applicable) to understand what each of the 25 checklist items requires. Present the information in your manuscript according to the guidelines.
(www.consort-statement.org)

2. With respect to the CONSORT checklist and guidelines, please ensure that submissions are correctly identified as randomized clinical trial (item 1a), that a structured summary is provided (item 1b-See CONSORT for abstracts), and that the background and study objectives are clearly defined (items 2a &2b). For the title please use the PICO+ format (not a CONSORT item) as in the example below:

ANNEX E – Guidelines for AJO-DO submissions: Randomized Clinical Trials (verso).

"A comparative assessment of orthodontic treatment outcomes using the PAR index (Outcome) between conventional (Comparator) and self-ligating brackets (Intervention) in adolescents (Participants): a multi-center, single blind randomized controlled trial (Design)"

Clearly define the study design (item 3), participants and settings (items 4a & 4b), interventions (item 5) and outcomes (items 6a & 6b), and clearly explain the assumptions underlying sample size calculations (item 7). Additionally, explain in detail all methods and processes pertaining to randomization (items 8-10), as their appropriate use will determine whether the study is a RCT or not. Blinding (item 11), if applicable, should be described at the investigator, participant, outcome assessor, and data analyst level. Explain the methods applied for statistical analyses for the main and any secondary outcomes (if applicable) and any methods used for subgroup or adjusted analyses (if applicable) (items 12a &12b). Please indicate participant flow by including a flow diagram (items 13a &13b), recruitment information (item 14), and a baseline table that presents the demographic and clinical characteristics for each group (item 15). Please include information on numbers analyzed (item 16), outcomes and estimation including effect estimate(s) and confidence intervals (items 17a &17b) and, if applicable, any results from ancillary analyses (item 18) and any harms (item 19). Please provide a thorough discussion (items 20-22) regarding trial limitations, applicability of results to other settings (generalizability), and interpretation of results, considering benefits and harms and in the context of the existing evidence. Finally, report if your trial was registered (item 23), if the trial protocol (item 24) was published before the commencement of the trial, and funding source(s) if any (item 25).

3. An editor will examine the randomized clinical trial manuscript for adherence to the CONSORT guidelines; if discrepancies are found, the manuscript will be returned with suggestions for changes either before the peer review process begins or with the reviewers' comments. The editor will be available to help authors to successfully implement the CONSORT guidelines.

4. Immediately effective all new RCT submissions must be structured using additional subheadings to the standard IMRaD format (Introduction, Methods, Results, Discussion).

An example of a published RCT following the newly required format may be found in the following link:
Annotated RCT Sample Article

ANNEX E – Guidelines for AJO-DO submissions: Randomized Clinical Trials (front).

ABSTRACT

The abstract should follow the CONSORT for abstracts and should include the following items:

Item	*Description*
Title	Identification of the study as randomized
Authors	Contact details for the corresponding author
Trial design	Description of the trial design (e.g. parallel, cluster, non-inferiority)
Methods	
Participants	Eligibility criteria for participants and the settings where the data were collected
Interventions	Interventions intended for each group
Objective	Specific objective or hypothesis
Outcome	Clearly defined primary outcome for this report
Randomization	How participants were allocated to interventions
Blinding (masking)	Whether or not participants, care givers, and those assessing the outcomes were blinded to group assignment
Results	
Numbers randomized	Number of participants randomized to each group
Recruitment	Trial status
Numbers analysed	Number of participants analysed in each group
Outcome	For the primary outcome, a result for each group and the estimated effect size and its precision
Harms	Important adverse events or side effects
Conclusions	General interpretation of the results
Trial registration	Registration number and name of trial register
Funding	Source of funding

Please add at the end of the abstract the following 3 items:

Registration

Protocol

Funding

The additional required subheadings are as follows:

INTRODUCTION

Specific objectives or hypotheses

ANNEX E – Guidelines for AJO-DO submissions: Randomized Clinical Trials (verso).

METHODS

Trial design and any changes after trial commencement

Participants, eligibility criteria, and setting

Interventions

Outcomes (primary and secondary) and any changes after trial commencement

Sample size calculation

Interim analyses and stopping guidelines

Randomization (random number generation, allocation concealment, implementation)

Blinding

Statistical analysis (primary and secondary outcomes, subgroup analyses)

RESULTS

Participant flow (include flow diagram, early stopping, and time periods)

Baseline data (include baseline table)

Numbers analyzed for each outcome, estimation and precision, subgroup analyses

Harms

DISCUSSION

Main findings in the context of the existing evidence, interpretation

Limitations

Generalizability

The CONSORT group encourages reporting of actual trial design and conduct. The goal is accurate and transparent documentation that will promote consistent reporting of clinical trials. Accurate presentation of the details of the trial, including possible limitations, allows the reader to place the trial results in the correct context. All available evidence is important and should be visible; thus, lower quality trials are not necessarily excluded or rejected, they just need to be accurately reported so that the evidence they provide can be placed in the right context.

ANNEX E – Guidelines for AJO-DO submissions: Randomized Clinical Trials (front).

The CONSORT guideline is an evolving process and is subject to reappraisal and possible future modifications. Future changes of the CONSORT guideline will result in an update of the requirements for submitting randomized clinical trials to the AJO-DO.

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