UNESP - Universidade Estadual Paulista
"Júlio de Mesquita Filho"
Faculdade de Odontologia de Araraquara

Patricia Pigato Schneider

Avaliação das alterações nos tecidos moles, do tempo de retração e da movimentação de incisivos, caninos e molares em casos de extrações de pré-molares

Araraquara

2019

UNESP - Universidade Estadual Paulista
“Júlio de Mesquita Filho”
Faculdade de Odontologia de Araraquara

Patricia Pigato Schneider

Avaliação das alterações nos tecidos moles, do tempo de retração e da movimentação de incisivos, caninos e molares em casos de extrações de pré-molares

Tese apresentada à Universidade Estadual Paulista “Júlio de Mesquita Filho” (UNESP), Faculdade de Odontologia de Araraquara, para obtenção do título de Doutor em Ciências Odontológicas, na área de Ortodontia.

Orientador: Prof. Dr. Luiz Gonzaga Gandini Júnior

Araraquara

2019

Schneider, Patricia Pigato
Avaliação das alterações nos tecidos moles, do tempo de retração e da movimentação de incisivos, caninos e molares em casos de extrações de pré-molares / Patricia Pigato Schneider. -- Araraquara: [s.n.], 2019
98 f. ; 30 cm.

Tese (Doutorado em Ciências Odontológicas) – Universidade Estadual Paulista, Faculdade de Odontologia
Orientador: Prof. Dr. Luiz Gonzaga Gandini Júnior

1. Ortodontia 2. Fechamento de espaço ortodôntico 3. Tempo para o tratamento 4. Procedimentos de ancoragem ortodôntica I. Título

Ficha catalográfica elaborada pela Bibliotecária Marley C. Chiusoli Montagnoli, CRB-8/5646
Universidade Estadual Paulista (Unesp), Faculdade de Odontologia, Araraquara
Serviço Técnico de Biblioteca e Documentação

Patricia Pigato Schneider

Avaliação das alterações nos tecidos moles, do tempo de retração e da movimentação de incisivos, caninos e molares em casos de extrações de pré-molares

Comissão julgadora

Tese para obtenção do grau de Doutor em Ciências Odontológicas, área de Ortodontia.

Presidente e Orientador: Prof. Dr. Luiz Gonzaga Gandini Júnior
2º Examinador: Prof. Dr. Gustavo Mattos Barreto
3º Examinador: Dr. Ki Beom Kim
4º Examinador: Prof. Dr. João Roberto Gonçalves
5º Examinador: Prof. Dr. Ary dos Santos Pinto

Araraquara, 22 de fevereiro de 2019.

DADOS CURRICULARES

Patricia Pigato Schneider

Nascimento:	20/05/1986 – Santa Maria/RS
Filiação:	Paulo Renato Schneider Sirlei das Graças Pigato Schneider
2006-2011:	Curso de Graduação em Odontologia pela Universidade Federal de Santa Maria.
2011-2014:	Curso de Especialização em Ortodontia pela Fundação Araraquarense de Ensino e Pesquisa em Odontologia, FAEPO – UNESP, Araraquara.
2012-2014:	Curso de Pós-graduação em Ciências Odontológicas, área de concentração em Ortodontia, nível Mestrado, pela Faculdade de Odontologia de Araraquara – FOAr – UNESP.
2014-2015:	Curso de Aperfeiçoamento em Ortodontia Preventiva e Interceptativa Extensiva – Prática e Clínica, pelo Grupo de Estudos Ortodônticos e Serviços, GESTOS, Araraquara.
2015-2019:	Curso de Pós-graduação em Ciências Odontológicas, área de concentração em Ortodontia, nível Doutorado, pela Faculdade de Odontologia de Araraquara – FOAr – UNESP.
2017-2018:	Estágio de Doutorado Sanduíche no exterior, no Center for Advanced Dental Education – CADE, na Saint Louis University, Saint Louis, MO, Estados Unidos.

Este trabalho é dedicado aos meus pais, ***Paulo Renato*** *e* ***Sirlei***, e aos meus irmãos, ***Clarissa*** *e* ***Paulo Sérgio***, por nunca permitirem que eu desistisse dos meus sonhos. Cada degrau que venho subindo na minha profissão só foi possível graças ao apoio que sempre encontrei em nossa família. Em todos os momentos da minha vida, eles foram meu porto seguro, no qual encontrei amparo para enfrentar os momentos de dificuldades que a vida me apresentou. Acredito que cada conquista alcançada é uma forma de agradecê-los por tudo aquilo que têm feito por mim.

A vocês a minha gratidão!

AGRADECIMENTO ESPECIAL

Ao meu orientador e grande amigo, ***Prof. Dr. Luiz Gonzaga Gandini Júnior***, para o qual não há agradecimentos que cheguem. És, sem dúvida alguma, o grande responsável pela minha formação como ortodontista e a pessoa na qual tenho me espelhado ao longo destes 7 anos de convivência durante a realização da minha especialização, mestrado e doutorado. Sou muito grata por ter possibilitado minha iniciação na carreira universitária e pela confiança que depositou em mim ao longa desta jornada, que foi essencial para o meu crescimento humano e profissional. Desta caminhada, levo comigo uma bagagem enorme dos seus ensinamentos ortodônticos, sua forma ética de pensar e de agir, sua pontualidade, sensatez e praticidade em resolver as coisas. A maneira como prioriza a vida familiar e pessoal dos seus alunos o torna um professor extremamente humano, que mantem forte laços de amizade com todos aqueles que têm a sorte de ter sido seu orientado. Minha gratidão estende-se a sua esposa e grande amiga, ***Márcia Regina E. Apª S. Gandini*** que se tornou a minha "mãezona" e orientadora do coração. Seu lado humano e seus conselhos, sempre tão sensatos, me ampararam em todos os momentos em que a insegurança se fez presente e me deram força para continuar esta longa jornada. Eles são os grandes responsáveis pela concretização do meu sonho de estudar na Saint Louis University. Sou muito grata por todas as oportunidades que me ofereceram e sinto-me muito orgulhosa de tê-los como orientadores! Meus agradecimentos também ao seus filhos, ***Alyssa*** *e* ***Eduardo***, pela acolhida sempre familiar e pelos muitos momentos de alegrias que compartilhamos ao longo destes anos; e, em especial, agradeço a amizade, acolhida e carinho da vovó ***Mafalda*,** que generosamente me recebeu em sua casa quando retornei dos Estados Unidos.

A vocês, a minha imensa admiração e o meu MUITO OBRIGADO.

AGRADECIMENTO ESPECIAL

Ao meu amigo e professor, ***Prof. Dr. Ary dos Santos Pinto***, o qual expresso meu sincero agradecimento, pelo incansável incentivo ao longo da minha caminhada acadêmica. Sua habilidade de compartilhar conhecimento, sobre todos os assuntos da ortodontia, e a sua humildade, em aprender com seus alunos, o tornam um dos professores mais brilhantes que já conheci! Sua paciência, generosidade e carisma no exercício da docência são reflexos do seu caráter. Sua constante colaboração foi fundamental para realização deste projeto e concessão da bolsa de estudos da FAPESP durante o curso de Doutorado. Esta conquista foi fundamental para que eu residisse em Araraquara ao longo destes anos e realizasse meu estágio no exterior. Agradeço por ter acreditado na minha capacidade profissional e pela oportunidade de ter tido sua orientação em todos os momentos que precisei.

Por toda paciência, amizade e colaboração na realização destes trabalhos,

ao senhor Prof. a minha gratidão e o meu MUITO OBRIGADO.

SPECIAL ACKNOWLEDGMENT

To my friend and mentor during the period I studied at Saint Louis University, ***Prof. Ki Beom Kim***, for allowing me to live one of the greatest academic opportunities of my life. Studying at Saint Louis University was really a dream that it would not have been possible without the welcome of this incredible mentor. He is an outstanding orthodontist, professor, researcher and the most important: an extraordinary human being. The story of his career, from leaving South Korea until reaching the important position of director in one of the best orthodontics school in the US, shows for us that all dreams are really possible. I am sure his history is a great example, not just to me but also for the orthodontists around all the world. I would like to express my gratitude for your orthodontic teachings, for your lectures and for having guided me with excellence in the writing of my articles. This incredible experience of living in the US changed my mind and made me a better person. The search for answers will be always something constant during all my life!

To you my gratitude,
I will always thank you for believe me and trust me.

AGRADECIMENTOS

A ***Deus***, pelo dom da vida e pelas oportunidades que me concedeu.

Aos meus pais, ***Paulo e Sirlei***, por não medirem esforços para que eu estudasse. O amor deles pela profissão sempre me contagiaram e fizeram com que almejasse ser como eles! Agradeço por me ensinarem que tudo é possível quando se tem dedicação, humildade e generosidade com o próximo. Pelo presença constante em minha vida, a vocês o meu mais sincero agradecimento.

Aos meus irmãos, ***Clarissa e Paulo Sérgio***, pelo amor e respeito que existe entre nós. Obrigada por serem sempre tão cuidadosos e atenciosos com a irmã caçula. Meu agradecimento especial a minha irmã, pelo suporte financeiro e emocional durante minha mudança para os EUA. Sem ela esse sonho não teria sido possível!

À ***Universidade Estadual Paulista "Júlio de Mesquita Filho"*** – UNESP, nas pessoas de seu Magnífico Reitor Dr. Sandro Valentini e do Excelentíssimo Senhor Vice-Reitor Dr. Sergio Roberto Nobre.

À ***Faculdade de Odontologia de Araraquara*** - FOAr, da Universidade Estadual Paulista Júlio de Mesquita Filho – UNESP, na pessoa da Excelentíssima Diretora Prof.ª Dr.ª Elaine Massucato e do Excelentíssimo Vice-Diretor Prof. Dr. Edson Campos.

Ao ***Programa de Pós Graduação em Ciências Odontológicas*** da Faculdade de Odontologia de Araraquara – FOAr/UNESP, representado pela Coordenadora Prof.ª Dr.ª Fernanda Brighenti e pela Vice coordenadora Prof.ª Dr.ª Alessandra Rastelli.

À **FAPESP e CAPES (PROCESSO: 2015/10099-0 - *Fundação de Amparo à Pesquisa do Estado de São Paulo)*** pela concessão da bolsa de estudos durante o curso de Doutorado, indispensável para o desenvolvimento destas pesquisas.

Ao ***Departamento de Clínica Infantil da Faculdade de Odontologia de Araraquara*** – FOAr/UNESP, representado pela Chefe de Departamento Prof.ª Dr.ª Lídia Martins e da Vice chefe Prof.ª Dr.ª Josimeri Costa.

Aos ***docentes das disciplinas de Ortodontia e Ortopedia Facial*** da Faculdade de Odontologia de Araraquara – FOAr/UNESP, Prof. Dr. Luiz Gonzaga Gandini Júnior, Prof. Dr. Ary dos Santos Pinto, Prof.ª Dr.ª Lídia Parsekian Martins, Prof. Dr. Dirceu Barnabé Ravelli, Prof. Dr. João Roberto Gonçalves e Prof. Dr. Maurício Tatsuei Sakima, por todos os ensinamentos que contribuíram com a minha formação profissional. Levarei comigo, entre as muitas lições, a paixão pelo ensino e o respeito ao próximo.

Ao colega ***Dr. André da Costa Monini***, agradeço a confiança que depositou em mim para que eu desse continuidade a estes trabalhos de pesquisas. Sem seu árduo trabalho, nada disso seria possível. A você a nossa gratidão!

Aos ***48 pacientes***, muito obrigado pela confiança, colaboração e consentimento que permitiram a realização destes estudos.

À ***Prof.ª Dr.ª Lídia Parsekian Martins***, pelo carinho e convívio sempre tão agradável. Agradeço por todos os ensinamentos ortodônticos e momentos vividos durante estes anos. Sua forma carinhosa e amigável de ser é fundamental para o acolhimento de todos os estudantes que se mudam para Araraquara e encontram nela uma verdadeira "mãezona".

Ao ***Prof. Dr. Dirceu Barnabé Ravelli*** por tudo que me ensinou e especialmente, por ter sido tão generoso comigo ao emprestar todo material necessário para que pudesse realizar a prova de especialização na UNESP. Agradeço também as sugestões, durante o exame de qualificação, que ajudaram a enriquecer estes trabalhos. És um professor extremamente humano e querido por todos. Minha gratidão estende-se a sua filha e amiga, ***Taíssa Ravelli***, pela amizade compartilhada ao longo destes anos e pelo seu constante incentivo, especialmente, quando morei em Saint Louis.

Ao ***Prof. Dr. João Roberto Gonçalves*** *e* a sua esposa ***Prof.ª Dr.ª Daniela Godoi Gonçalves****, aos quais* tenho como grande exemplo. São professores extremamente educados, dedicados e competentes em tudo que fazem. Eu agradeço ao convívio, sempre harmonioso, e pelas conversas que me estimularam para que eu fosse estudar no exterior. Fico muito feliz em ter alguém que admiro tanto em minha banca de defesa do doutorado, muito obrigada.

Ao amigo e ***Prof. Dr. Gustavo Barreto***, pelo incentivo na minha caminhada. És um ortodontista e professor talentoso, extremamente humano, ético e humilde; que tem inspirado muitos ortodontistas com a sua trajetória. Agradeço pelos conselhos, sempre muito sinceros, e por aceitar o convite para fazer parte da minha banca de defesa de doutorado.

Aos ***docentes das disciplinas de Odontopediatria*** da Faculdade de Odontologia de Araraquara – FOAr/UNESP, Prof.ª Dr.ª Fernanda Brighenti, Prof.ª Dr.ª Ângela Cristina Zuanon, Prof.ª Dr.ª Elisa Maria Giro, Prof.ª Dr.ª Josimeri Costa, Prof.ª Dr.ª Lourdes dos Santos Pinto, Prof.ª Dr.ª Rita Cordeiro, Prof. Dr. Cyneu Pansani e Prof. Dr. Fábio Lima, pelos ensinamentos e convivência agradável no departamento de Clínica Infantil.

A todos os ***funcionários do Departamento de Clínica Infantil*** da Faculdade de Odontologia de Araraquara – FOAr/UNESP e, especialmente à ***Sônia*** **Maria Tircailo** (***Soninha***) pela sua solidariedade e bom convívio dentro do departamento de Clínica Infantil. Sua dedicação, cuidado e carinho foram fundamentais durante o período que morei em Araraquara.

Aos ***técnicos em prótese ortodôntica****,* Diego Pendenza, Antônio Cabrini e Pedro Alves, pela colaboração na execução dos aparelhos ortodônticos utilizados nesta amostra e pela amizade construída ao longo destes anos.

A todos os ***funcionários da Seção de Pós-Graduação da Faculdade de Odontologia de Araraquara***- UNESP, especialmente aos amigos José Alexandre Garcia e Cristiano Lamounier, por sempre me tratarem com gentileza e estarem dispostos a ajudar.

Aos ***funcionários da Fundação de Amparo à Pesquisa do Estado de São Paulo***, especialmente, ao amigo Renan Cesar Palomino por toda paciência e amparo durante a solicitação da bolsa e elaboração de todos os relatórios.

Aos ***colegas do curso de Pós-Graduação em Ciências Odontológicas – Área de concentração em Ortodontia,*** Luis Filipe Lon, Roberto da Silva Junior, Talles Oliveira, Priscila Ayub, Cibele de Oliveira, Isabela Martins, João Paulo Schwartz, Wendel Shibasaki, Ingrid Letra, Juan Mariscal, Lucas Campos, Taíssa Ravelli, Cláudia Nakandakari, Luégya Knop, Ricardo Shintcovsk, Kelei Almeida, Éder Mastropietro, Eddy Navarro, Layene Almeida, Jaqueline Negrão, Marlos Loiola, Bruno Minervino, Alexandre Zilioli, Tatyane Mesquita, Jonas Bianchi, Paulo Marchi, Glaucia de Oliveira, Anderson Cunha e Carolina Leão. Obrigado a todos vocês pelo companheirismo e aprendizado ortodôntico ao longo destes anos.

Ao amigos ***Luis Filipe Lon e Roberto da Silva Junior***, meus irmãozinhos da turma, pela amizade verdadeira que construímos e pela disponibilidade em me ajudar sempre que precisei!

A minha little sister, ***Ingrid Ledra,*** pelo companheirismo de todas as horas e por ser uma amiga extremamente motivadora. Agradeço por ter estado ao meu lado, mesmo quando a distância se fez presente.

Aos colegas e amigos ***Tales Oliveira, Juan Francisco, Lucas Arrais, Jaqueline Negrão, Priscila Ayub e Anderson Cunha,*** pela amizade sincera e, especialmente por se mostraram disponíveis para me ajudar sempre que precisei.

Aos ***amigos do curso de Pós-Graduação em Ciências Odontológicas – Área de concentração em Odontopediatria*** Natália Domingues, Rafael Amaral, Diego Girotto, Ana Carolina Mendes, Vinícius Krieger, Yasmin Albuquerque, Silas Alves, Bianca Nubia e Marina Lins. Agradeço a acolhida na turma da “Pedi” e por todos momentos de alegria que compartilhamos.

À ***Saint Louis University*** e ao ***Center for Advanced Dental Education*** **- CADE**, na pessoa do diretor do departamento da Ortodontia Prof. Dr. Ki Beom Kim.

Aos ***docentes* do *Center for Advanced Dental Education - CADE*,** Prof. Dr. Ki Beom Kim, Prof. Dr. Rolf Behrents, Prof. Dr. Eustáquio Araújo, Prof. Bill Mastarakos, Prof. Ueno Hiroshi, Prof. Eugene Hayes, Prof. Patrick Foley e a Prof.ª Julie McCray, pelo acolhimento na escola e por todos os ensinamentos que contribuíram para o desenvolvimento destes estudos.

Ao ***Prof. Dr. Guilherme Almeida***, pela amizade e companheirismo durante o período que estudei em Saint Louis. Minha admiração se tornou ainda maior depois deste período de convivência, onde pude perceber o professor talentoso e humilde que és. Meu agradecimento pelo apoio e sua disposição em me ajudar, sempre que precisei.

Aos **funcionários do *Grupo de Estudos Ortodônticos e Serviços* - GESTOS**, Adriana Cardinali, Ariela Fuzari, Eloísa Bertole, Pamela Cabrera, Vanessa Rosa, Vilma Machado e, especialmente, a Márcia Delgado, pelo carinho e confiança no meu trabalho ao longo destes anos.

À amiga e **Prof.ª Dr.ª *Luana Paz Sampaio***, por ter sido uma amiga sempre solidária e generosa. Só tenho a agradecer por ter sido a minha família em Araraquara e por todos os momentos que compartilhamos. Ela foi, sem dúvida alguma, uma grande incentivadora para que eu desse novos e desafiadores passos na minha carreira como Ortodontista.

Aos ***docentes da Faculdade de Odontologia da Universidade Federal de Santa Maria*** – UFSM, especialmente, aos Prof. Dr. Renésio Grehs e Prof. Dr. Vilmar Ferrazzo, meus primeiros professores de Ortodontia. Agradeço por terem impulsionaram o início da minha carreira e por todos os ensinamentos que foram fundamentais para meu aceite na UNESP. Meu agradecimento se estende a Prof.ª Dr.ª Kívia Ferrazzo, por ter instruído os meus primeiros passos na iniciação científica. Vocês são grandes exemplos de profissionais que carrego na minha vida. A vocês, e a todos os professores da UFSM, o meu respeito e gratidão!

Ao ***Prof. Dr. Romeu Magnani e ao Prof. Dr. Paulo Renato Schneider (meu pai)***, pelo suporte estatístico nestas pesquisas. Agradeço a meticulosa atenção aos inúmeros dados conseguidos com estes trabalhos e por todos os seus ensinamentos.

As ***funcionárias do Gandini & Gandini ortodontistas***, Rose Luciano e Simone Cusumano, pelo carinho, respeito e amizade ao longo destes anos.

Às minhas professora de inglês, ***Bárbara Andrade e Laura Johnson***, por terem acreditado em mim e me encorajado nesse grande desafio que foi estudar no exterior.

Aos amigos ***Natália Domingues, Aion Messias e Beatriz Panariello*** que tornaram meus últimos anos em Araraquara tão leves e felizes. Juntos construímos "uma família", na qual podemos recorrer sempre que precisar!

À amiga ***Betina Grehs Porto***, pela sua confiança, acolhimento e carinho nos momentos que mais precisei. Sua confiança, quando mudou para os EUA e confiou a mim seu consultório e seus pacientes. Seu acolhimento, durante minha mudança para os EUA, na qual encontrou um lugar onde pudesse morar. Seu carinho, este estendido durante toda a minha trajetória e que fortaleceu ainda mais nosso laço de amizade.

Aos queridos amigos ***Rafael Amorin, Lais Pavan, Ana Carolina Mendes, Camila Lorenzeti e Camila Marcantônio*** para os quais cabem muitos agradecimentos. Agradeço por todos os momentos de alegrias que compartilhamos e, especialmente, pela acolhida em suas famílias durantes estes anos que morei sozinha em Araraquara.

Aos meus amigos do Rio Grande do Sul, ***Gabrielle Adams**, **Carolina Rosa**, **Taline Cheron**, **Gabriel Dal Forno** e **Carolina Druck**,* por provarem que verdadeiras amizades não terminam com a distância. Obrigada pelo apoio e por terem proporcionados momentos tão felizes nos reencontros.

As amigas-irmãs ***Mariana Basílio**, **Maysa Vasconcelos, Rachel Mendonça e Mylena Ranieri,*** por terem sido minha "família" nos anos que moramos em Araraquara.

A todos os ***amigos*** que me ajudaram a caminhar durante este período importante da minha vida,

MUITO OBRIGADA!

“A mente que se abre a uma nova ideia

jamais voltará ao seu

tamanho original.”

Albert Einstein*

* Einstein. Como vejo o mundo. Rio de Janeiro: Nova Fronteira; 1934.

Schneider PP. Avaliação das alterações nos tecidos moles, do tempo de retração e da movimentação de incisivos, caninos e molares em casos de extrações de pré-molares [tese de doutorado]. Araraquara: Faculdade de Odontologia da UNESP; 2019.

RESUMO

Os fechamentos dos espaços das extrações pode ser realizados utilizando duas técnicas principais: retração em massa (RM) ou retração em duas etapas (RDE). Os objetivos principais destes estudos foram avaliar a retração dos incisivos, as mudanças nos tecidos moles e o tempo de retração entre RM e RDE; bem como as taxas de movimentação dos caninos e molares superiores durante a primeira etapa de fechamentos dos espaços utilizando a RDE. A amostra foi composta por modelos, telerradiografias cefalométricas em norma lateral e oblíqua de 45º obtidos antes e durante o tratamento ortodôntico de 48 pacientes biprotrusos cujo os tratamentos foram realizados com extrações de quatro primeiros pré-molares. Todos os pacientes da amostra haviam sido alocados aleatoriamente para o grupo de tratamento utilizando RM (n = 24) ou RDE (n = 24). A retração dos incisivos e as alterações nos tecidos moles foram avaliadas por meio de radiografias cefalométricas em norma lateral do pré-tratamento (T1) e pós-tratamento (T2). Para análise do tempo de retração, o tamanho dos pré-molares foram medidos nos modelos e os dados, referentes ao atendimento clínico, foram coletados dos prontuários nos seguintes tempos: data do início da retração (T1) e data do término do fechamento de espaço (T2). Os movimentos dos caninos e molares superiores foram analisados através das radiografias cefalométricas oblíquas em 45º obtidas antes da retração (T0) e durante o tempo de fechamento dos espaços das extrações: 1º (T1), 3º (T3), 5º (T5) e 7º (T7) mês. Os testes não paramétricos, o método de Kaplan Meier e a análise de regressão linear foram utilizados para análise estatística. Os resultados mostraram que a quantidade de retração dos incisivos e as alterações nos tecidos moles não foram estatisticamente diferentes entre os grupos. Entretanto, o tempo de retração apresentou diferenças significativas entre a RM e RDE. Enquanto o RM levou entre 12,1 e 13,8 meses, o RDE levou entre 24,7 e 26,8 meses para fechar os espaços das extrações. Durante a RDE, as taxas de movimentação dos caninos e molares maxilares foram significativamente maiores durante o 1º mês de retração, no qual foi de 1,32mm para as cúspides dos caninos e 0,82mm para as cúspides dos molares. Após o 1º mês de retração, ambos iniciaram uma fase linear em que as taxas de movimentação mensais permaneceram constantes até o final do período de retração, estimado em média de 0,58 mm para as cúspides dos caninos e 0,30 mm para as cúspides dos molares. As principais conclusões obtidas com estes estudos são que as duas técnicas de retrações proporcionam quantidade similares de retração dos incisivos e mudanças nos tecidos moles. Entretanto, a RDE irá requerer de 1,8 a 2,2 vezes mais tempo para fechar os espaços das extrações do que a RM. Além disso, o 1º mês de retração é o período de maiores taxas de movimentação para ambos, caninos e molares, durante a primeira etapa dos fechamentos dos espaços utilizando a RDE. Após esse período, as taxas de movimentação mensal destes dentes são constantes até o 7º mês de retração.

Palavras chave: Ortodontia. Fechamento de espaço ortodôntico. Tempo para o tratamento. Procedimentos de ancoragem ortodôntica.

Schneider PP. Evaluation of soft tissue changes, retraction time and movement of incisors, canines and molars in cases of premolar extractions [tese de doutorado]. Araraquara: Faculdade de Odontologia da UNESP; 2019.

ABSTRACT

The extraction space closing can be performed using two main retraction techniques: en masse retraction (ER) or two-step retraction (TSR). The main objectives of these studies were to evaluate incisor retraction, soft tissue changes and retraction time between ER and TSR; as well as the movement rates of the maxillary canines and molars during the first step of space closing using the TSR. The sample consisted of models, lateral and oblique cephalometric radiographs at 45º obtained before and during the orthodontic treatment of 48 adult patients with bimaxillary protrusion whose treatments were performed with extractions of four first premolars. All patients had been randomly allocated to either ER (n=24) group or TSR (n=24) group. Both incisor retraction and soft tissue changes were evaluated using pretreatment (T1) and posttreatment (T2) lateral cephalometric radiographs. To analyze the retraction time, the size of the premolars were measured in the models and data were collected from the clinical records in the following times: retraction start date (T1) and space closure completion date (T2). Both maxillary canine and molar movements were analyzed by oblique cephalometric radiographs at 45º taken before the retraction (T0) and during the follow-up of extraction space closing time: on the 1st (T1), 3rd (T3), 5th (T5) and 7th (T7) month. The principal investigator traced, superimposed and digitized all cephalograms from the lateral and oblique cephalometric radiographs at 45º using DFPlus®. The nonparametric tests, Kaplan Meier method and linear regression analysis were used for statistical analysis. The results showed that the amount of incisor retraction and soft tissue changes showed no significant differences between the two groups. However, the retraction time presented significant differences between ER and TSR. While the ER took about 12.1 and 13.8 months, the TSR took about 24.7 and 26.8 months to close the extraction spaces. During the TSR, the maxillary canine and molar movement rates were significantly greater during the 1st month of retraction at which it were of 1.32mm for the canine cusps and 0.82mm for the molar cusps. After the 1st month of retraction, both of them started a linear phase in which monthly movement rates remained constant until the end of the follow-up time, estimated on average of 0.58 mm for the canine cusps and 0.30 mm for the molar cusps. The main conclusions from these studies are that the two retraction techniques, ER and TSR, provide similar amount of incisor retraction and changes in the soft tissues. However, the TSR will require between 1.8 and 2.2 more time than ER to close the extraction spaces. In addition, the 1st month of retraction is period of greatest movements of canines and molars during the first step of space closing with TSR. After this time, the monthly movement rates are constant until the 7th retraction month.

Keywords: Orthodontic. Orthodontic space closure. Time to treatment. Anchorage procedures orthodontics.

SUMÁRIO

1 INTRODUÇÃO

A biprotrusão dentoalveolar caracteriza-se pela protrusão e proclinação dos dentes incisivos superiores e inferiores, resultando em ângulo nasolabial agudo, aumento da protrusão dos lábios e convexidade da face[1–3]. Neste caso, os lábios protrusivos criam um efeito negativo sobre a percepção da estética do sorriso e do perfil facial[1,4,5], e esta condição é inaceitável por muitos pacientes que procuram por tratamento ortodôntico[3,6].

De maneira geral, as alterações nos tecidos moles associadas à redução da biprotrusão no pós-tratamento não são totalmente previsíveis[2,7]. Entretanto, é bem aceito pelos clínicos que a decisão de extrair os quatro primeiros pré-molares tende a melhorar a convexidade da face[1–3,6–9] e produzir um perfil facial esteticamente mais agradável do que um perfil cujo tratamento ortodôntico foi realizado sem extrações[9,10].

Uma vez que as extrações tenham sido planejadas durante o tratamento, deve-se decidir como serão realizados os fechamentos dos espaços residuais. Existem duas estratégias biomecânicas principais: a retração em massa (RM) ou a retração em duas etapas (RDE)[11,12]. A abordagem mais tradicional é o processo sequencial de retração, em que caninos e incisivos são retraídos em duas etapas distintas e separadas (RDE). Nesta técnica, os caninos são distalizados individualmente até o contato com os segundos pré-molares, seguido pela retração dos quatro incisivos na segunda etapa[11–14]. Por outro lado, quando os espaços residuais são fechados através da RM, incisivos e caninos são retraído como se fossem um único bloco e em apenas uma etapa[15].

Em geral, a escolha entre esses dois métodos de retração depende da preferência do ortodontista[16], mas a maioria dos clínicos optam pela RDE quando os pacientes necessitam de ancoragem máxima durante o tratamento[11]. Tradicionalmente, acredita-se que o maior número de raízes na unidade de ancoragem, composta pelo segundo pré-molar, primeiro e segundo molares, são mais resistentes ao movimento anterior enquanto apenas uma raiz canina é retraída[17,18]. Desta forma, espera-se que a força mesial resultante na unidade posterior seja menor e, consequentemente, minimize a perda de ancoragem durante a retração[13,15,19].

Considerando que essa hipótese é verdadeira, surge a pergunta: Se a RDE é realmente capaz de retrair os dentes anteriores em uma maior extensão, então as alterações nos tecidos moles são mais evidentes em pacientes com biprotrusão dentoalveolar? Apesar de Burstone[20] já ter sugerido que a magnitude da redução da biprotrusão é determinada pelo sistema de forças aplicado entre os segmentos anterior e posterior dos dentes, durante os fechamentos dos espaços, nenhum Ensaio Clínico Randomizado (RCT) examinou a relação entre as duas principais técnicas de retrações e as mudanças ocorridas nos tecidos moles. Até o momento, esta relação foi examinada apenas em relação ao uso de dispositivos de ancoragem temporária (DAT)[6,9,21].

Além de procedimentos clínicos e biomecânicos que otimizem os resultados terapêuticos, os ortodontistas estão em busca de mecanismos que resultem em menor tempo de tratamento[22]. Nos casos de biprotrusão dentoalveolar, deve-se considerar que o tratamento com extrações tem sido associado a tempo de tratamento mais longo[23–26]. Segundo Fink e Smith[27], cada extração de pré-molar aumenta o tempo de tratamento em, aproximadamente, 0,94 meses; sendo que os casos tratados com quatro extrações de pré-molares levam mais tempo do que aqueles que foram tratados com apenas duas extrações[27,28]. Obviamente, além das extrações, outros fatores podem afetar a duração total do tratamento ortodôntico[23–25,29], tais como: a cooperação do paciente, suas características dentárias e faciais; bem como a experiência clínica do ortodontista. No entanto, até o momento, o tempo despendido durante os fechamentos dos espaços utilizando a RM ou RDE, não foi adequadamente explorado na literatura e esta questão ainda precisa ser investigada.

O tempo de retração foi relatado apenas como resultado secundário em poucos estudos[16,30] os quais sugeriram que a RDE requer tempo maior de tratamento do que a RM, porém as diferenças não foram estatisticamente significativas. Além disso, nenhum estudo foi encontrado na literatura explorando o tempo de fechamento de espaço para cada pré-molar extraído, uma vez que, em um mesmo paciente, os espaços das extrações podem fechar em momentos diferentes.

Até o momento, não há consenso em ortodontia sobre como os dentes podem ser movimentados com maior eficiência[31,32] e as retrações individuais dos caninos têm sido referenciadas como a etapa mais demorada durante o tratamento ortodôntico com extrações[11,13,30,33,34]. Assim sendo, compreender as taxas mensais de movimentação dos caninos pode ser a chave para prever os fechamentos dos espaços[23] e estabelecer estratégias individuais para cada paciente durante esta etapa do tratamento.

Porém, os estudos em humanos que descreveram os deslocamentos dos caninos, utilizando molas fechadas de NiTi[31,35–41], relataram velocidades de retração altamente variáveis. Nestes estudos, a taxa de movimentação foi calculada dividindo a quantidade de deslocamento da cúspide do canino pelo tempo necessário para completar a retração[31,35–37,39–41]. Isto significa que os autores assumiram que os dentes tiveram a mesma velocidade de movimentação durante todo o período de avaliação. Entretanto, resultados de estudos em animais, têm mostrado que isto não é verdade, e que existem diferentes taxas de movimentação durante o deslocamento dos dentes. Além disso, estudos demonstrando a perda de ancoragem, durante a retração individual do canino, são especialmente difíceis de encontrar[38,41].

Visto que, a ativação do aparelho ortodôntico é geralmente realizada a cada quatro semanas, surgem as seguintes questões: As velocidades dos caninos e molares são as mesmas durante todo o fechamento dos espaços de extração?

Considerando a escassez de Informações a respeito das questões abordadas, os propósitos destes estudos foram avaliar a retração dos incisivos, as mudanças nos tecidos moles e o tempo de retração entre RM e RDE, bem como as taxas de movimentação dos caninos e molares superiores durante a primeira etapa de fechamentos dos espaços utilizando a RDE.

2 PROPOSIÇÃO

Este trabalho tem por objetivo avaliar a retração dos incisivos, as mudanças nos tecidos moles e o tempo de retração, bem como a movimentação de molares e caninos, em pacientes biprotrusos cujos tratamentos foram realizados com extrações de quatro primeiros pré-molares e utilizando dois protocolos de fechamento de espaços.

- Avaliar a retração dos incisivos e as alterações nos tecidos moles em relação a dois protocolos de fechamento de espaço.

- Avaliar o tempo de fechamento dos espaços da extração, para cada pré-molar, em relação a dois protocolos. Secundariamente, avaliar o tempo de fechamento dos espaços para pacientes do gênero masculino e feminino.

- Avaliar os movimentos dos caninos e molares durante a primeira etapa de fechamentos dos espaços utilizando a RDE. Secundariamente, avaliar as taxas de movimentação desses dentes.

3 PUBLICAÇÕES

Esta tese de Doutorado foi escrita em três publicações correspondentes a versão em inglês de artigos científicos elaborados para publicação em periódicos internacionais.

Publicação 1- Does en masse or two-step space closing produce different results for incisors retraction and soft tissue changes? A randomized prospective clinical trial.

Publicação 2- Which one closes extraction spaces faster: en masse retraction or two-step retraction? A randomized prospective clinical trial.

Publicação 3- Maxillary canine and molar movement rates during extraction space closing.

3.1 Publicação 1*

Does en masse or two-step space closure produce different results for incisors retraction and soft tissue changes?

A randomized prospective clinical trial

* Artigo escrito segundo as normas bibliográficas da revista ***The Angle Orthodontist.***

Does en masse or two-step space closure produce different results for incisors retraction and soft tissue changes?
A randomized prospective clinical trial

ABSTRACT

Objectives: The purpose of this randomized prospective clinical trial was compare the treatment effects of incisors retraction and soft tissue changes after closing the extraction spaces with en masse (ER) or two-step retraction (TSR). **Materials and methods:** A sample of 48 Brazilians patients (18-34 years) with bimaxillary protrusion requiring 4 first premolar extractions were randomized in stratified blocks assigned in a 1:1 ratio. The randomization was used to ensure that the groups would be balanced for the two retraction techniques either ER (n=24) group or TSR (n=24) group. The main outcome was to compare the incisors retraction and soft tissues changes between ER and TSR; the differences between the beginning and the end of treatment intragroup was a secondary outcome. The changes were evaluated using pretreatment (T1) and posttreatment (T2) lateral cephalometric radiographs. The cephalograms were traced and digitized in the software DFPlus® by the principal investigator who was blinded for the group. The normal distribution of data was checking by Shapiro-Wilk test and paired t-tests were used to determine the statistical significance between T2-T1 within each group and between the groups. The level of significance of 5% was adopted ($\alpha = 0.05$). **Results:** The amount of incisors retraction and soft tissue changes showed no significant differences between ER and TSR groups. However, there were significant differences intragroup in the overjet, tipping and retraction of incisors; as well as in the thickness and retraction of lips after treatment. **Conclusions:** The closing of spaces with ER or TSR provided a similar amount of incisors retraction and changes in the soft tissues. The posttreatment changes were favorable for both retraction techniques.

Keywords: Orthodontic treatment; Bimaxillary protrusion; Soft tissue; En masse retraction; Two-step retraction.

INTRODUCTION

Bimaxillary protrusion is characterized by dentoalveolar flaring of both the maxillary and mandibular incisors that produce an increased procumbency of the lips, decreased nasolabial angle and convexity of the lower face.[1–3] In general, the protrusive lips creates a negative perception of smile esthetics and of the facial profile,[2,4,5] and this condition is unacceptable for many patients who seek orthodontic care.[3,6]

One of the most controversial topics in orthodontics is the decision of whether to extract or not.[7] In essence, soft tissue changes associated with reduction of dentoalveolar protrusion at posttreatment are not totally predictable.[1,8] However, it is rather well accepted by orthodontists that the extractions decision of four first premolars tends to improve the convexity of the face[1–3,6,8–10] and produce a facial profile that is more esthetically pleasing than a nonextractions profile.[11,12] In this scenario, the choice of a retraction technique that supposedly it would distalize more the anterior teeth during the extraction space closing could be the key for the success of treatment, increasing the probability of correcting the facial profile at the end of the bimaxillary protrusion treatment.[1,2,10,13,14]

Extraction space closing can be performed using two main biomechanical strategies: en masse retraction (ER) or two-step retraction (TSR).[10,15–22] In the TSR approach, the canines are distalized independently and followed by retraction of four incisors in a second step. In the ER, all six anterior teeth are retracted at the same time. Most clinicians believe in the classical hypothesis that when TSR is chosen it reduces the anchorage loss through incorporating more teeth in the posterior unit,[15,18] and for this reason, it has been the orthodontists' clinical choice for many years.[15,21] In this way, they assume the hypothesis that this technique is more appropriate for patients who require maximum anchorage during the treatment. Considering whether this hypothesis is true, came the question: If the TSR is able to retract the anterior teeth to their greatest extent, then the soft tissue changes would be optimized in patients with bimaxillary protrusion?

Although Burstone[13] has already suggested that the magnitude of anterior dental reduction and the resulting changes in lips position are determined by the system of forces between the anterior and posterior teeth segments during space closing, no Randomized Clinical Trial (RCT) has examined the relationship of the retraction techniques and the soft tissue changes. To the author's knowledge, until date, the effect of orthodontic treatment with extractions on the soft tissue profile was examined only in relation to the use of temporary anchoring devices[6,10,14]. Since bimaxillary protrusion patients could benefit from a technique that results in greater retraction of the anterior teeth, this question still needs to be investigated.

Specific objective

The main aim of this RCT was to investigate the treatment effects on incisors retraction and soft tissue changes after closing the extraction space with ER or TSR, in adults with bimaxillary protrusion undergoing extraction of all 4 first premolars.

MATERIALS AND METHODS

The subjects were recruited from consecutive patients during their initial visits to the Department of Orthodontics, Araraquara School of Dentistry, São Paulo State University. The approval for this study was obtained by the Ethics Committee on Human Research of this institution (ethical approval No. 01/09) (ANEXOS).

Trial design

This was a parallel-group, randomized, active controlled trial with a 1:1 allocation ratio. No changes occurred to the design after trial commencement.

Subjects

Fifty-two participants were initially recruited and examined for this study (Figure 1). Four participants did not meet the inclusion criteria. The selection criteria were as follows: Brazilian ethnic, at least 17 years of age, Class I molar relationships, bimaxillary protrusion, mild crowding in upper and lower incisors ≤ 4 mm, presence of all permanent teeth (except third molars), no previous orthodontic treatment, good oral hygiene and no systemic diseases.

Pretreatment lateral cephalograms (T1) were obtained during the sample selection to quantify the initial protrusion of all subjects by linear and angular measurements (Tables 1 and 2; Figure 2).

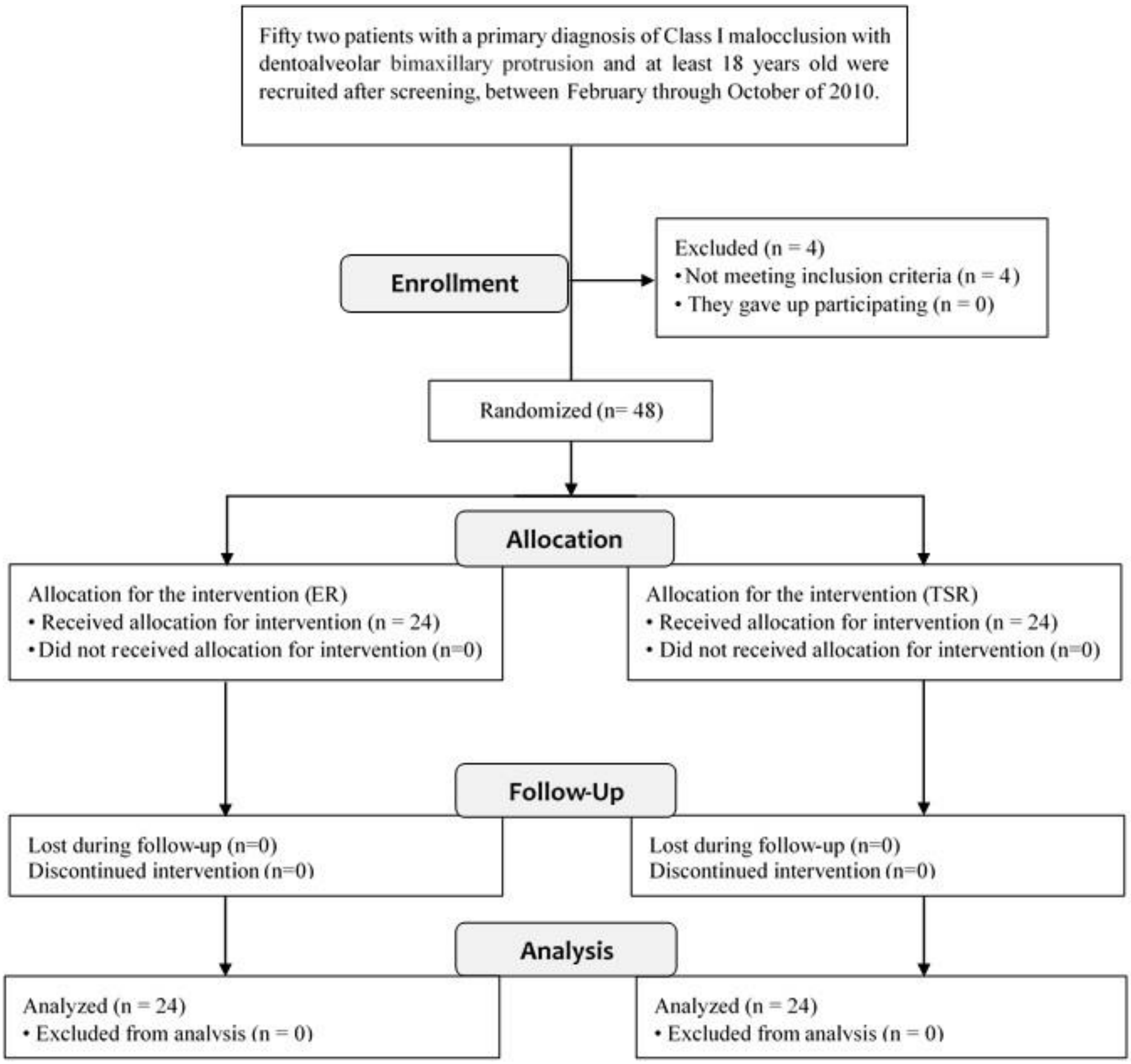

Figure 1. CONSORT flow chart showing subjects through the trial.

Table 1. Descriptions of analyzed variables.

Measurement	Variable	Definition
Dental measurements		
U1.SN-7° (º)	U1 tipping	Angular distance formed by the upper incisor axis and SN-7°line
L1.SN-7° (º)	L1 tipping	Angular distance formed by the lower incisor axis and SN-7°line
U1-H (mm)	Horizontal movement of the U1	Horizontal distance from upper incisor tip to Y line
L1-H (mm)	Horizontal movement of the L1	Horizontal distance from lower incisor tip to Y line
U1-V (mm)	Vertical movement of the U1	Vertical distance from upper incisor tip to X line
L1-V (mm)	Vertical movement of the L1	Vertical distance from lower incisor tip to X line
OJ (mm)	Overjet	Horizontal distance between U1 and L1
OB (mm)	Overbite	Vertical distance between U1 and L1
Soft tissue measurements		
Sbn-Es (mm)	Upper lip length	Vertical distance from Sbn to Es
Ls-Es (mm)	UL thickness	Vertical distance from Ls to Es
Ei-Li (mm)	LL thickness	Vertical distance from Ei to Li
Ls-H (mm)	Horizontal movement of the Ls	Horizontal distance from upper lip to Y line
Li- H (mm)	Horizontal movement of the Li	Horizontal distance from lower lip to Y line
Ls-V (mm)	Vertical movement of the Ls	Vertical distance from upper lip to X line
Li-V (mm)	Vertical movement of the Li	Vertical distance from lower lip to X line
NLA (º)	Nasolabial Angle	Angular distance between Int, Sbn, and Ls
MLA (º)	Mentolabial Angle	Angular distance between Li, Lmf and Pog'

Table 2. Comparation of characteristics of subjects between ER and TSR at T1.

Variable (T1)	ER		TSR		t test		
	Mean	SD	Mean	SD	t	P value(a)	Sig
Skeletal							
SNA (º)	90.81	4.63	91.39	5.03	-0.410	0.680	ns
SNB (º)	84.35	4.29	84.85	3.97	-0.420	0.674	ns
ANB (º)	6.45	3.25	6.53	2.51	-0.100	0.917	ns
SNGoMe (°)	31.83	6.22	29.84	5.89	1.130	0.263	ns
FMA (°)	25.95	4.88	23.97	5.66	1.300	0.200	ns
SN.Plo (°)	11.47	4.34	10.23	5.13	0.900	0.367	ns
PgNperp (°)	-0.46	6.73	1.15	8.08	-0.750	0.457	ns
AFH (mm)	126.30	8.35	125.70	11.13	0.190	0.848	ns
PFH (mm)	83.66	7.22	85.96	8.33	-1.020	0.312	ns
PFH/AFH (mm)	66.35	5.01	68.59	6.41	-1.350	0.183	ns
Convexity (NA-Apo) (°)	13.53	7.57	13.89	6.22	-0.180	0.860	ns
Dental							
IMPA (°)	102.10	5.90	103.10	6.10	-0.580	0.567	ns
U1.SN-7° (º)	115.00	5.65	116.30	5.37	-0.780	0.439	ns
L1.SN-7° (º)	104.40	3.80	105.00	4.95	-0.420	0.678	ns
U1.L1 (°)	109.70	7.88	111.20	8.63	-0.640	0.527	ns
U1-H (mm)	89.22	6.33	89.11	5.91	0.006	0.951	ns
L1-H (mm)	84.34	6.32	85.58	5.91	-0.700	0.488	ns
U1-V (mm)	71.95	6.35	69.19	8.59	0.730	0.469	ns
L1-V (mm)	69.21	6.58	68.81	7.78	0.660	0.512	ns
OJ (mm)	3.86	1.08	3.98	0.84	-0.430	0.666	ns
OB (mm)	2.03	1.20	2.02	1.49	-0.410	0.406	ns
Maxillary crowding (mm)	3.63	0.63	3.54	1.19	0.330	0.741	ns
Mandibular crowding (mm)	2.75	0.79	2.83	0.70	-0.350	0.729	ns
Soft tissue							
Sbn_Es (mm)	25.43	2.94	24.78	3.40	0.700	0.485	ns
Ls-Es (mm)	10.72	1.90	10.65	2.53	0.100	0.923	ns
Li-Ei (mm)	9.42	1.50	9.02	2.72	-0.620	0.535	ns
Ls-H (mm)	98.98	6.13	101.00	6.22	-1.120	0.269	ns
Li-H (mm)	97.19	7.54	97.97	6.95	-0.370	0.713	ns
Ls-V (mm)	58.49	5.19	56.29	7.37	0.690	0.496	ns
Li-V (mm)	82.26	7.13	79.26	9.95	1.200	0.236	ns
NLA (º)	91.15	22.28	88.36	18.16	0.470	0.637	ns
MLA (º)	136.26	7.37	142.52	7.94	-2.850	0.007	*

*Significant differences by the Student's *t* test at $P \leq .05$; ns, not significant and SD, standard deviation.

[a]Between ER and TSR at T1.

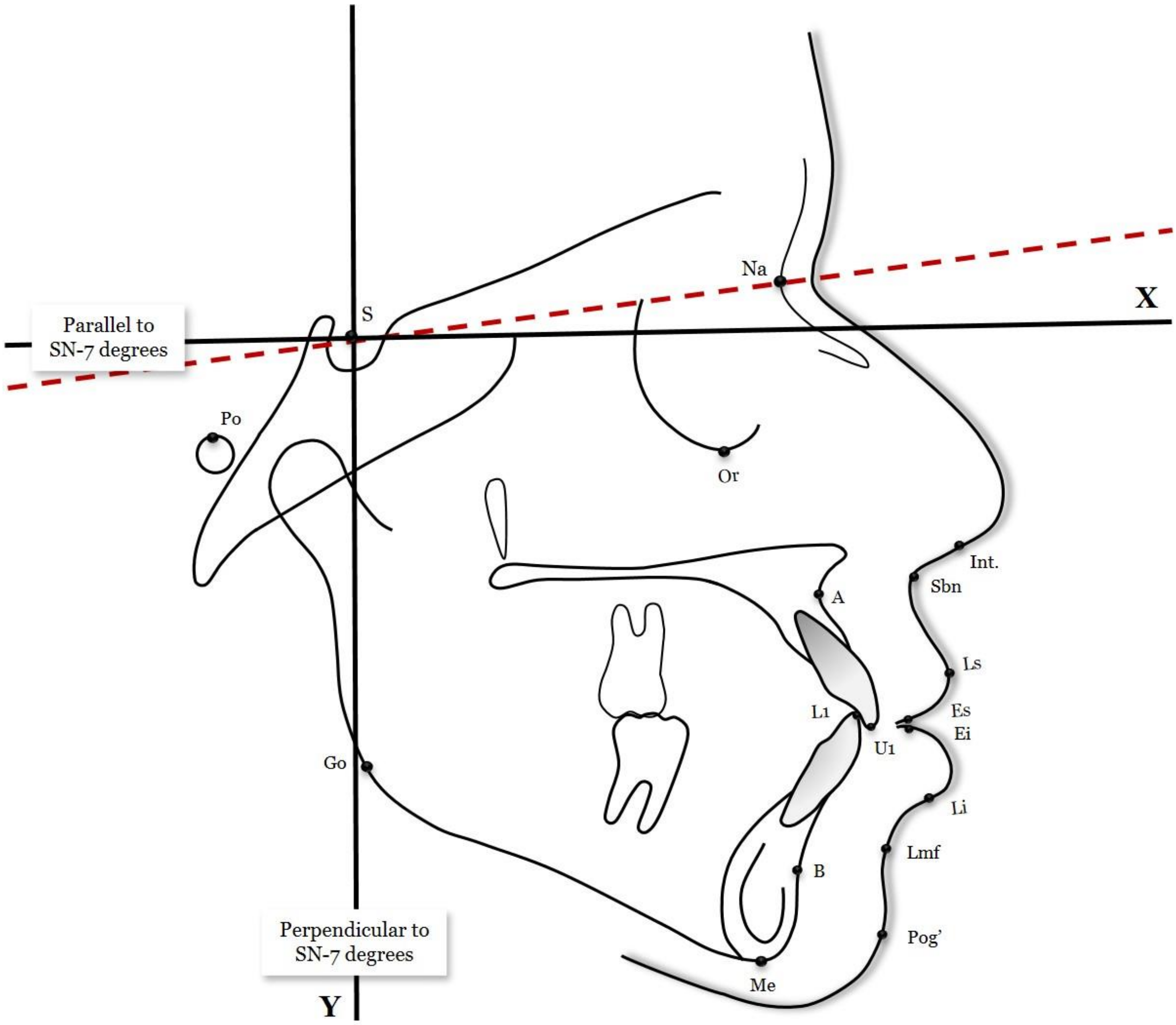

Figure 2. Landmarks and reference planes used in the analysis. Landmarks: S, Sella; Na, Nasion; Int, Inferior nasal tip; Sbn, Subnasale; Ls, Labrale Superius; Es, Estomy Superius; Ei, Estomy Inferius; Li, Labrale inferius; Lmf, Labiomental fold; Pog', Soft tissue pogonion; U1, Upper incisor tip; L1, Lower incisor tip; A point, Subspinale; B point, Supramentale; Me, Menton ; Go, Gonion; Or, orbit and Po, Orbitale. Planes: X and Y.

After informed consent, 48 patients matching the inclusion criteria were randomly assigned to two groups according with the retraction technique that would be used: ER group or TSR group (Figure 1). The patients' baseline was showed in Table 3.

Table 3. Baseline pretreatment characteristics of the sample.

Group	Gender	n	Starting age (y)		Age range (y)	
			Mean	SD	Min	Max
ER	Female	14	23.9	3.8	19	32
	Male	10	23.5	2.8	19	28
TSR	Female	15	22.1	5.1	17	34
	Male	9	21.6	3.3	17	28

SD, standard deviation; y, years.

Interventions

Both groups were treated with extraction of 4 first premolars. Conventional 0.022-in straight-wire brackets (Ovation-GAC, Bohemia, NY) were bonded from the right second premolar to the left second premolar and 0.022-in tubes were soldered to bands of the first and second molars in both sides. Leveling and aligning were conducted until 0.020-in stainless steel (SS) wires could be passively inserted into the brackets and there was no more anterior crowding, then the four first premolars were extracted. After 7-14 days after extractions, the retraction mechanic was activated and a 0.010” stainless steel ligature wire was used to tie from second premolar to second molars at both groups. No auxiliary anchorage devices were used during the treatment.

In the ER group, all of the anterior teeth were tied with 0.010” ligature and retracted in a single step on a 0.017” X 0.025”-in SS archwires using Nickel-titanium (NiTi) closed-coil springs, activated to 200gm (GAC, Bohemia, USA), attached from a soldered hook placed between the lateral incisor and the canine to the cervical hook of the first molars bands (Figure 3A). In the TSR group, the canines were first retracted individually on 0.020-in SS arch wire, with flush omega loops tied back to the first molars. NiTi closed-coil springs activated to 100gm were secured from the hooks of first molars to the hooks of the canine brackets until the bilateral retractions were completed. After retraction of canines, these teeth were tied with the posterior teeth using 0.010” ligature wire and the incisors were retracted en masse on an 0.017”X0.025” SS wires using NiTi closed-coil activated to 100gm attached from the soldered hook placed distal to the lateral incisor to the cervical hook of the first molars bands (Figure 3B). All of the incisors also were tied with 0.010” ligature wire during the second step of the retraction. During each appointment, every 4-5 weeks[23,24], the springs were removed and checked by Correx Tension Gauge (Haag-Streit, Bern, Switzerland) to maintain the same activation until the spaces closure was complete (Figures 3, 4, 5 and 6).

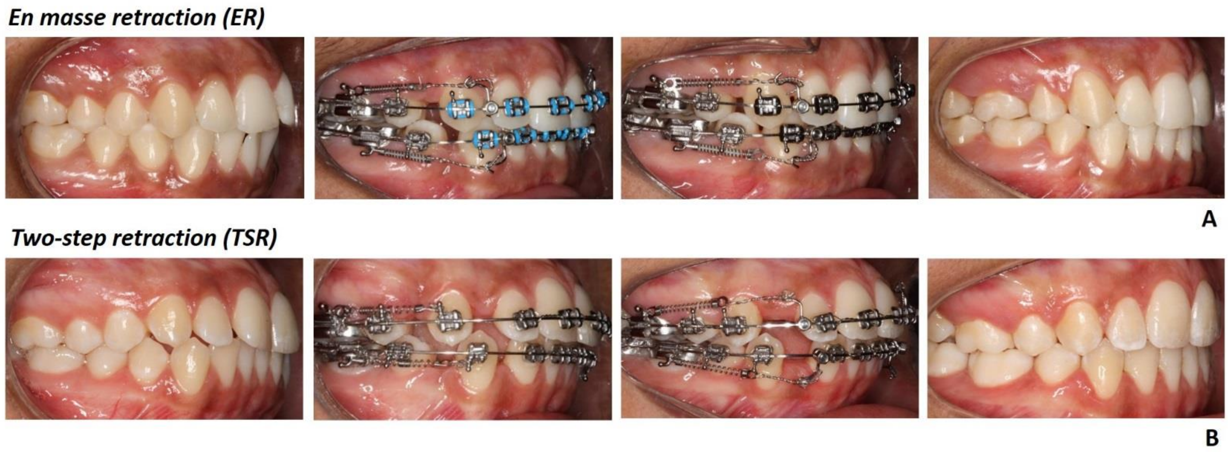

Figure 3. Illustration of the space closing: A) ER group; B) TSR group.

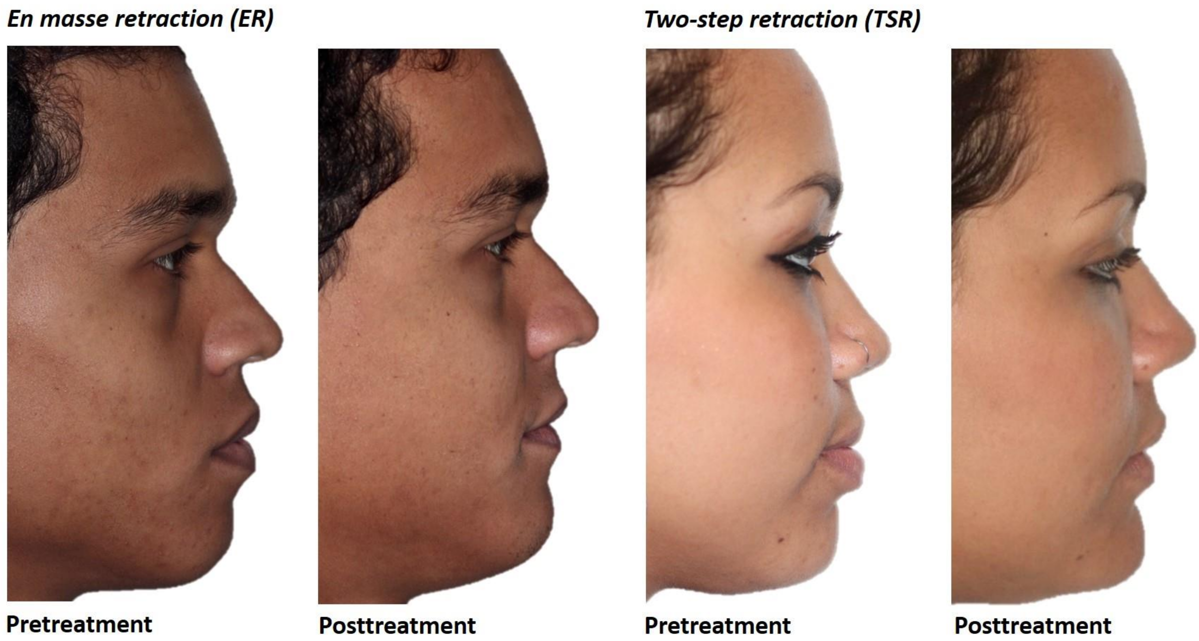

Figure 4. Illustration of the soft tissue changes at pretreatment and posttreatment for ER and TSR groups.

Lateral cephalometric radiographs and cephalograms

Lateral cephalometric radiographs for each subject were taken at pretreatment (T1) and posttreatment (T2) (Figure 5A and 5B), using a Rotograph plus machine with exposure factors for scan captured images regulated in 85 Kvp, 10 mA and 0,5 seconds. The positioning of the head, guided by the cephalostat, kept the Camper Plane[25] parallel to the ground and the head parallel to the film. All cephalometric radiographs were taken with the patients in maximum intercuspation and with the lips relaxed[26], as instructed by the principal investigator.

Tracings of all radiographs were drawn with 0.3-mm mechanical pencil on 0.03mm thick tracing paper (GAC International Inc.). Landmarks were identified on each T1 and T2 cephalograms (Figure 2). Both cephalograms of each patient were placed side by side on the viewer to minimize errors in locating cephalometric landmarks. When there was a double image, the midpoint between the 2 points was traced.

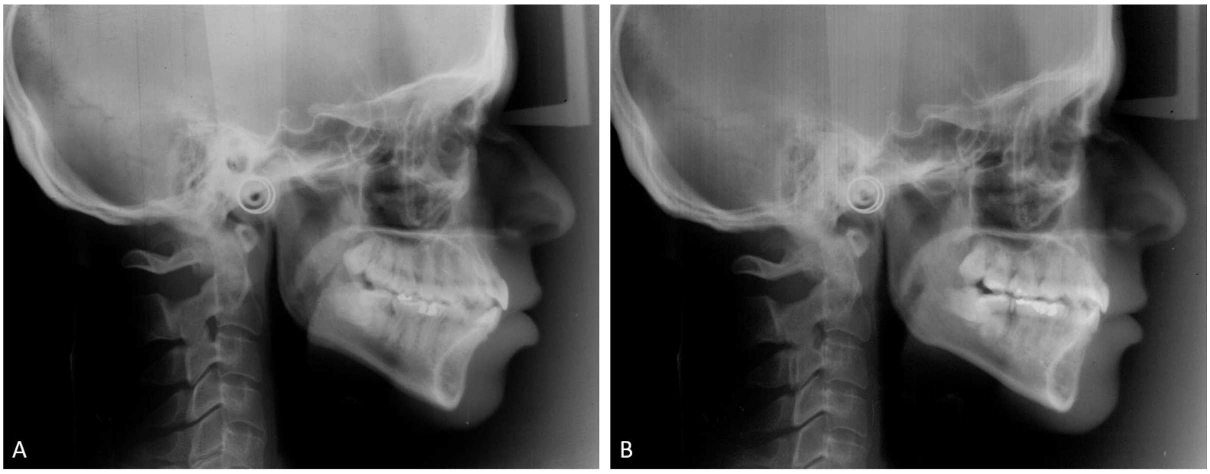

Figure 5. Illustration of lateral cephalometric radiographs at pretreatment (A) and posttreatment (B).

Cephalometric analysis

The landmarks were digitized using Dentofacial Planner software (version 7.0; Dentofacial Planner, Toronto, ON, Canada). In this software, horizontal and vertical positions of landmarks were measured in relation the distance from them to Cartesian coordinate system: the x-axis was constructed by subtracting 7º from sella-nasion line[27] and a line perpendicular to it, through Sella, served as the y-axis. The landmarks and reference planes and abbreviations used in this study are shown in Figure 2 and Table 1. The values were measured on T1 and T2 cephalograms and transferred to a Microsoft Excel spreadsheet (Office Excel 2013; Microsoft Corporation, Redmond, Washington, USA). The software created the average superimposition of both pretreatment (T1) and posttreatment (T2) cephalograms for each group (Figure 6).

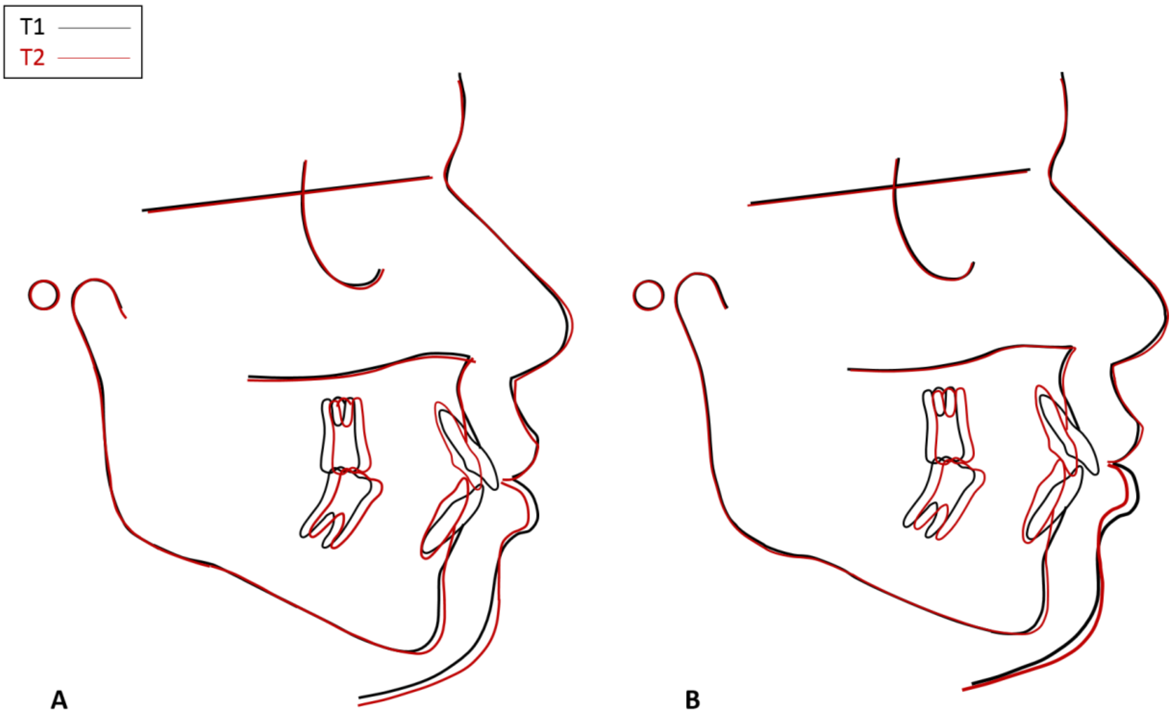

Figure 6. Average superimposition of both T1 and T2 cephalograms at ER group (A) and TSR group (B).

Blinding

The patients and the investigator were blinded to the allocation sequence, but it was impossible to blind them to the treatment method. However, the outcome assessment was blind. Blinding of the investigator during the tracing and digitizig of the all radiographs was ensured by assigning a number to each radiography to anonymize the patient's group.

Outcomes and any changes after trial commencement

The main outcome was to compare the incisors retraction and soft tissue changes between ER and TSR; the differences between the pretreatment (T1) and posttreatment (T2) intragroup was the secondary outcome. No changes were made after trial commencement.

Error of the method

The principal investigator traced and scanned all cephalograms. Fifteen randomly selected patients had their scanned cephalograms and measured twice, at an interval of 4 weeks, to assess reliability. Reliability was evaluated using intraclass correlation (ICC) and estimated by means of confidence intervals. All these values were greater than 0.85.

Statistical Analysis

All statistical analyses were performed with SAS software package (Statistical Analysis System. version 9.3). The homogeneity of variance of the data was determined by the Bartlett test. Normality of the distribution of variables were confirmed by the Shapiro-Wilk test, Student t-test was used to compare the groups at pretreatment. Pooled t-tests were used to determine the statistical significance between pretreatment and posttreatment within each group and between the two groups. The level of significance of 5% was adopted ($\alpha = 0.05$).

RESULTS

The CONSORT diagram shows the flow of subjects through the trial (Figure 1). The baseline data of the patients at T1 are shown in Table 2 and 3. All selected subjects showed similar characteristics at T1. No significant differences were found in the dental, skeletal or soft tissue parameters between ER and TSR, except for the MLA variable (Table 2).

Table 4 and Figures 3, 4, 5 and 6 represent the pretreatment and posttreatment (T2-T1) comparison within each ER and TSR groups. The comparison of treatment changes between ER and TSR groups are shown in Table 5.

Dental changes

The upper and lower incisor measurements showed there were significant differences from T1 to T2 intragroup (Table 4) only for some angular (U1.SN-7 °; L1.SN-7°) and linear (U1-H, L1-H, OJ) measurements. However, there were no significant differences in horizontal displacements and angular variables between ER and TSR groups.

Soft tissue changes

There were statistically significant backward retraction of the upper and lower lips retraction (Ls-H, Li-H) from T1 to T2, in within each group, and an increase in the lip thickness (Ls-Es, Ei-Li). The intergroup differences were not statistically significant for any of the variables studied.

Variable	ER							TSR						
	T1		T2		t test			T1		T2		t test		
	Mean	SD	Mean	SD	t	P value[(a)]	Sig	Mean	SD	Mean	SD	t	P value[(b)]	Sig
Dental														
U1.SN-7° (º)	115.00	3.72	105.20	6.56	6.230	<0.001	*	116.30	5.37	106.10	5.21	7.390	<0.001	*
L1.SN-7° (º)	104.40	3.80	94.87	4.07	8.410	<0.001	*	105.00	4.95	94.81	4.98	7.090	<0.001	*
U1-H (mm)	89.22	6.33	84.76	6.33	2.440	0.019	*	89.11	5.91	84.49	5.64	2.770	0.008	*
L1-H (mm)	84.34	6.38	79.75	6.27	2.650	0.011	*	85.58	6.02	80.70	6.02	2.900	0.006	*
U1-V (mm)	71.95	6.35	70.60	6.50	0.730	0.472	ns	70.35	8.59	69.19	8.82	0.460	0.646	ns
L1-V (mm)	69.21	6.58	70.18	6.63	0.510	0.613	ns	67.95	7.78	68.81	7.86	0.380	0.706	ns
OJ (mm)	3.86	1.08	2.95	1.03	3.000	0.004	*	3.98	0.84	2.94	0.66	4.780	<0.001	*
OB (mm)	2.03	1.20	1.90	0.78	0.460	0.651	ns	2.02	1.23	2.34	0.94	-1.030	0.308	ns
Soft-tissues														
Sbn_Es (mm)	25.43	2.94	27.01	4.12	-1.530	0.132	ns	24.78	3.40	26.48	3.55	-1.690	0.098	ns
Ls-Es (mm)	10.72	1.90	12.14	2.14	-2.440	0.019	*	10.65	2.53	12.58	2.61	-2.600	0.012	*
Li-Ei (mm)	9.42	1.50	10.38	1.86	2.070	0.044	*	9.02	1.50	10.03	1.86	-2.070	0.044	*
Ls-H (mm)	98.98	2.14	96.35	1.90	2.340	0.010	*	101.00	2.58	98.58	2.52	2.680	0.010	*
Li-H (mm)	97.19	6.59	94.09	6.73	1.930	0.044	*	97.97	7.41	95.12	4.83	1.920	0.048	*
Ls-V (mm)	58.49	5.19	60.74	5.79	-1.420	0.164	ns	56.29	7.69	57.95	8.31	-0.720	0.475	ns
Li-V (mm)	82.26	7.13	81.25	7.22	0.490	0.627	ns	79.26	9.95	78.35	9.74	0.320	0.749	ns
NLA (º)	91.15	22.28	97.80	21.43	-1.050	0.297	ns	88.36	18.16	95.25	19.40	-1.270	0.211	ns
MLA (º)	136.26	7.37	139.20	7.47	-1.370	0.177	ns	142.52	9.85	146.30	8.72	-1.410	0.166	ns

* Significant differences by the Pooled *t*-test at $P \leq .05$; ns, not significant; SD, standard deviation.

[a]Between T1 and t2 at ER group; [b]Between T1 and T2 at TSR group.

Table 5. Comparison of treatment changes (T2-T1) between ER and TSR groups.

Variables	ER		TSR		t test		
Measurements	Mean	SD	Mean	SD	t	P value[(a)]	Sig
Dental							
U1.SN-7° (º)	-9.80	2.67	-10.20	1.50	0.83	0.513	ns
L1.SN-7° (º)	-9.53	1.02	-10.19	1.56	-1.57	0.124	ns
U1-H (mm)	-4.46	1.28	-4.62	1.02	-0.5	0.620	ns
L1-H (mm)	-4.59	1.22	-4.88	1.17	-0.62	0.542	ns
U1-V (mm)	-1.35	0.52	-1.16	0.52	1.22	0.229	ns
L1-V (mm)	0.97	0.45	0.86	0.44	0.87	0.387	ns
OJ (mm)	-0.91	0.44	-1.04	0.56	-0.89	0.379	ns
OB (mm)	-0.13	0.59	-0.32	0.52	0.05	0.959	ns
Soft-tissue							
Sbn_Es (mm)	1.58	1.77	1.70	2.98	-0.16	0.874	ns
Ls-Es (mm)	1.42	1.18	1.93	2.01	-1.06	0.295	ns
Li-Ei (mm)	0.96	1.62	1.01	1.27	0.12	0.906	ns
Ls-H (mm)	-2.63	2.51	-2.42	0.95	-0.44	0.662	ns
Li-H (mm)	-3.10	2.18	-2.85	1.22	-0.49	0.626	ns
Ls-V (mm)	2.25	2.80	1.66	2.44	1.17	0.247	ns
Li-V (mm)	-1.01	0.88	-0.92	0.84	0.39	0.701	ns
NLA (º)	6.65	3.23	6.89	5.63	-0.18	0.861	ns
MLA (º)	2.94	2.27	3.78	4.06	-0.89	0.378	ns

*Significant differences by the Pooled *t*-test at $P \leq .05$; ns, not significant; SD, standard deviation.

[a]Between ER and TSR groups; Negative values indicant distal movement of the incisors and lips (horizontal), intrusion movement of the U1 and extrusion movement of the Li (vertical); Positives values indicant intrusion movement of the L1, extrusion movement of the Ls (vertical) and increase in Sbn_Es, Ls-Es, Li-Ei, NLA and MLA.

Harms

No participant reported a negative outcome during the trial.

DISCUSSION

Obviously many confounding factors can influence the interpretation of the true soft tissue changes, such as: weight change, variations in morphology, tonicity and musculature of lips.[3,26,28] Therefore, the meticulous selection of patients and methodology of this trial was carefully designed to reduce many of variables that could have affected adversely the results:

1) The sample was formed only by adult patients, since growth can overestimate or underestimate the extraction effects.[11] This might be explained from either mandibular development and prolonged nasal growth up to adulthood or age-related changes of the lips.[29–31]

2) Only patients who needed extractions of the four first premolars were selected for this study, since different extractions protocols were significantly associated with the different effects at posttreeatment.[11]

3) The crowding was quantified during sample selection. Basciftci and Usumez[32] reported that the greater the amount of crowding, the smaller the amount of incisors retraction.[29]

4) There were no statistically significant difference in skeletal, dental, and soft tissue measurements between the groups at T1 (Table 2), confirming the characteristics of bimaxillary protrusion of the whole sample and the homogeneity between the groups, which allowed them to be compared.

5) Only the Brazilian ethnicity was selected for this study, since different populations may respond differently to anterior retraction.[33] Racial aspects could not be considered during the sample selection because of the ethnic diversity and extensive admixture of the Brazilians population.[34,35]

6) The treatment plan used in this study involved the alignment and leveling of all teeth with a 0.020-in SS wire before the extractions of premolars[21]. In this way, the initial positions of the teeth were standardized at the beginning of the retraction and thus, avoided differences that could influence soft tissue changes.

7) Additional anchorage devices were not used during space closing. Solem et al.[6] and Upadhyay et al.[10] demonstrated that when ER was accomplished with skeletal anchorage, 1.5 mm more lower lip retraction[6] was achieved and more change were produced in the facial convexity angle and nasolabial angle.[10] In this way, the use of these devices mask the real effects of the retraction techniques at soft tissue changes.

8) Sliding mechanics with NiTi open-coil springs were chosen for closure of extraction spaces. NiTi springs are the most common method used by orthodontists,[36] and their super elasticity and shape-memory phenomenon are favorable for the spaces closing.[24]

9) When the X-rays were taken, each patient was asked to maintain the lips relaxed. According to Burstone,[26] the standardization of the lips positions increases the reproducibility of the soft tissue measurements. However, lip tension can vary between subjects and the inability to control this variable was a shortcoming of this study.[28]

10) The reference planes created were established by Sella-Nasion line minus 7º [27,37]. This line is not only stable but also biologically meaningful, as it represents the anterior cranial base and many studies have shown it is a reproductive method.[8,10,14,27]

The results reported in Table 4 indicated that there were significant incisor retractions after the treatment within each group, but without significant differences between ER and TSR techniques. There is just one RCT with similar results to our study, also conducted without the use of the anchoring devices.[38] The mean backward movements between groups in relation to the crown retraction were of -4.54 ± 1.15 mm for the upper incisors and of -4.73 ±1.32 mm for lower incisors, with decrease of ± 1 mm in the overjet and maintenance of overbite. Lee et al.,[14] Solem et al.,[6] and Upadhyay et al.,[10] found similar values but these findings cannot be directly compared because they used conventional anchorage reinforcement during the retraction.

The tipping movements were also investigated. The crown movements were accompanied by on average -11,54º ± 2.16º of reduction in the upper incisors proclination and -9.86º ± 1.34º in the lower incisors, improving the interincisive relationship. In this way, the ratio of incisors tipping to the mean incisor retractions was approximately 2:1 and the intrusive movements in the vertical direction was less than 1.4 mm for both retraction techniques (Table 5). Since the inclination and protrusion of the incisors were similar between the groups at T1 (Table 2), one possible explanation for these results is that the forces produced by the NiTi springs were applied far from the center of resistance.[20] Besides that, there were gaps between the wire and the slot during the retraction which may have made it difficult to control the torque during the movement.[39] Creekmore[40] showed that when the 0.019″ × 0.025″-in SS archwire was applied to a 0.022-in slot, it resulted on average of 10.5º of expression torque, consistent with our results.

The changes in dental positions were accompanied by soft tissue changes which produced improvement the facial profile (Figures 4, 5 and 6). The upper lips retracted on average -2.51 ± 1.88 mm for both retraction techniques, while for the lower lips the mean was -2.98 ± 1.75 mm. Thus, the ratio of upper lip retraction to the mean upper incisor retraction was 0.6:1 for ER and 0.5:1 for TSR. In the same way, at the lower arch it was 0.7:1 and 0.5:1 respectively (Table 5). These results indicate that extractions treatment are associated with an additional retraction of the lower lip, as it has already been reported previously in the orthodontic literature.[11] Greater retraction of the lower lip was expected, since during the bimaxillary protrusion treatment the lower lip often contacts both upper and lower incisors and therefore, it would be influenced by the retraction of both these teeth[10]. However, significant difference had been found in the MLA at T1 in our study and individual characteristics may have affected these results[3,26,28].

In the vertical direction, both upper and lower lips showed extrusive movements which favored the lip sealing at end of treatment. The length of the upper lips increased on average ± 1.6 mm, but these differences were not significant at the end of treatment. In contrast, the lips thickness increased significantly from T1 to T2 in each ER and TSR groups, on average 1.67 ± 1.59 mm for upper lips and 0.98 ± 2.37 mm for lower lips. The results of our study can be compared to those their Konstantonis,[41] Keser et al.,[42] and Talass et al.,[43], who reported a significant value, yet larger, for the increase of upper lip at extraction group: 2.17 mm, 2.8 mm and 3.70 mm respectively. In addition, it should be considered that the measurements were performed at the most anterior point of the lips. In this way, with the lips retraction the Ls point tended to turn down,[44] increasing the length and thickness of the lips.

The reduction of the bimaxilar protrusion was accompanied by an increase of on average 6.77°± 4.54º in the NLA for both groups, even though this change was not statistically significant at posttreatment. It must be noted that highly variable NLA changes were found from patient to patient (Figure 7). These means that tooth extractions cannot consistently predict[43] a significant increase of the NLA and the results will depend on individual biological response.[3,26,28] Regarding to the opening of the NLA for each millimeter of upper incisor retraction, the ratio was 1.5º:1 for both retraction techniques (Table 5), similar to the proportion already reported by Almeida et al.[45] and Konstantonis et al.[11] However, the studies available in the literature that reported greater NLA increase after treatment, it used miniscrews as anchorage[10,33] or the patients were growing.[11,29]

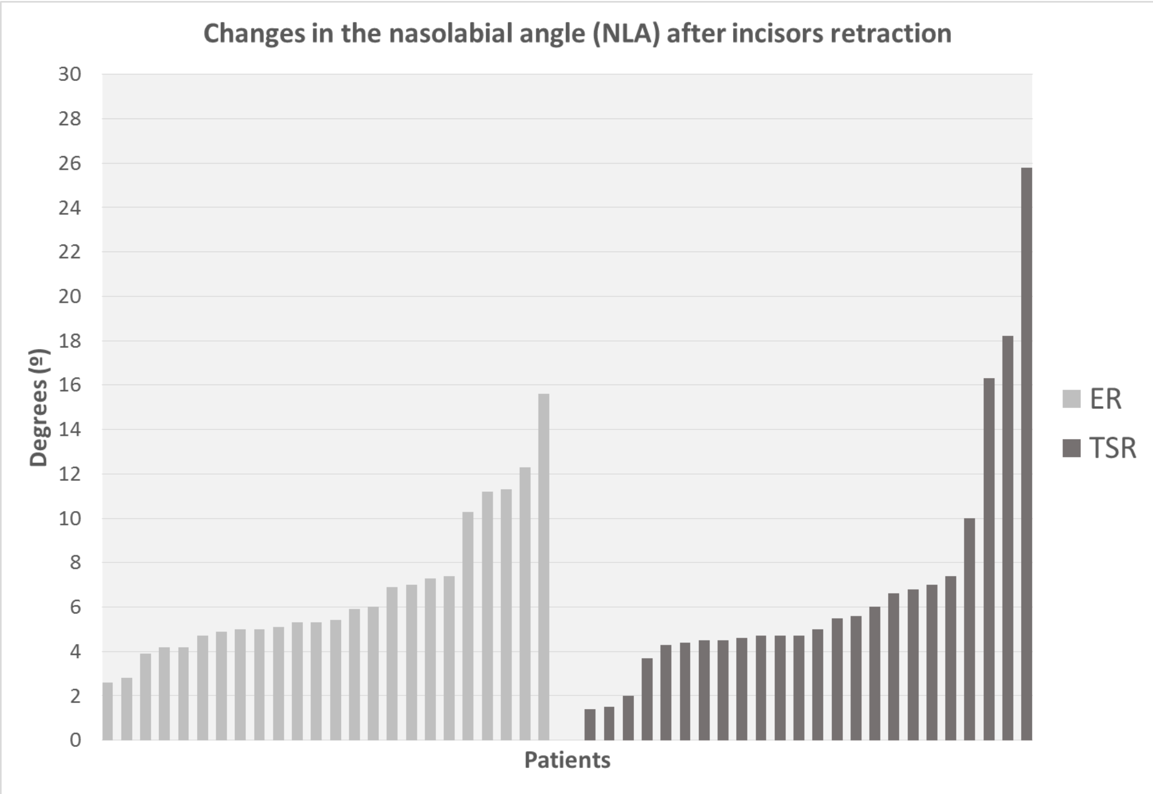

Figure 7. NLA changes for each patient of sample at posttreatment.

These results suggest that both ER and TSR techniques will show favorable results at the end of the treatment with extractions of four premolars. However, the choice between the two retraction techniques will not lead to greater soft tissue changes. While new studies are not performed to compare with our results, the orthodontist must consider the individual characteristics of each technique. Individual retractions of canines often results in disto-palatal rotations and mesiodistal tipping of these teeth[10,15,18] and therefore, may require additional treatment time to realign them.[18,20] None of these problems were found with ER.[10] Furthermore, ER eliminates the appearance of unsightly spaces distal to the lateral incisors following canine retractions.[10,20] These findings enable us to consider ER to close the extraction spaces. If there are anterior crowding or midline discrepancy, the TSR should be considered.[20] When more retraction of the anterior teeth are need to modify the patient's profile, then additional anchorage reinforcement should be associated.

CONCLUSIONS

The following conclusions can be drawn from this study:

- The incisors retraction and soft tissue changes between pretreatment and posttreatment were favorable for both en masse and two-step retractions. However, the changes were similar between the two retraction techniques.
- No significant differences exist in the amount of incisor retraction and its tipping between the two groups;
- Magnitudes of the changes in the soft tissue were similar between the two space closing methods.

ACKNOWLEDGEMENTS

We thank for all the support provided from São Paulo Research Foundation (FAPESP), process nº 2015/10099-0, School of Dentistry at Araraquara (UNESP), Brazil and Center for Advanced Dental Education (CADE) at Saint Louis University, USA.

REFERENCES

1. Farrow AL, Zarrinnia K, Azizi K. Bimaxillary protrusion in black Americans--an esthetic evaluation and the treatment considerations. *Am J Orthod Dentofacial Orthop.*1993;104:240–50.

2. Bills DA, Handelman CS, BeGole EA. Bimaxillary dentoalveolar protrusion: traits and orthodontic correction. *Angle Orthod.* 2005;75:333–9.

3. Leonardi R, Annunziata A, Licciardello V, Barbato E. Soft tissue changes following the extraction of premolars in nongrowing patients with bimaxillary protrusion. *Angle Orthod.* 2010;80:211–6.

4. Almutairi TK, Albarakati SF, Aldrees AM. Influence of bimaxillary protrusion on the perception of smile esthetics. *Saudi Med J.* 2015;36:87–93.

5. Scott SH, Johnston LE. The perceived impact of extraction and nonextraction treatments on matched samples of African American patients. *Am J Orthod Dentofacial Orthop*.1999;116:352–60.

6. Solem RC, Marasco R, Guiterrez-Pulido L, Nielsen I, Kim SH, Nelson G. Three-dimensional soft-tissue and hard-tissue changes in the treatment of bimaxillary protrusion. *Am J Orthod Dentofacial Orthop.* 2013;144:218–28.

7. Almurtadha RH, Alhammadi MS, Fayed MMS, Abou-El-Ezz A, Halboub E. Changes in Soft Tissue Profile After Orthodontic Treatment With and Without Extraction: A Systematic Review and Meta-analysis. *J Evid Based Dent Pract.* 2018;18:193–202.

8. Kusnoto J, Kusnoto H. The effect of anterior tooth retraction on lip position of orthodontically treated adult Indonesians. *Am J Orthod Dentofacial Orthop.* 2001;120:304–7.

9. Drobocky OB, Smith RJ. Changes in facial profile during orthodontic treatment with extraction of four first premolars. *Am J Orthod Dentofacial Orthop.* 1989;95:220–30.

10. Upadhyay M, Yadav S, Nagaraj K, Patil S. Treatment effects of mini-implants for en-masse retraction of anterior teeth in bialveolar dental protrusion patients: a randomized controlled trial. *Am J Orthod Dentofacial Orthop.* 2008;134:18-29.

11. Konstantonis D, Vasileiou D, Papageorgiou SN, Eliades T. Soft tissue changes following extraction vs. nonextraction orthodontic fixed appliance treatment: a systematic review and meta-analysis. *Eur J Oral Sci.* 2018;126:167–79.

12. Iared W, Koga da Silva EM, Iared W, Rufino Macedo C. Esthetic perception of changes in facial profile resulting from orthodontic treatment with extraction of premolars: A systematic review. *J. Am Dent Assoc.* 2017;148:9–16.

13. Burstone CJ. The segmented arch approach to space closure. *Am J Orthod Dentofacial Orthop.* 1982;82:361–78.

14. Liu YH, Ding WH, Liu J, Li Q. Comparison of the differences in cephalometric parameters after active orthodontic treatment applying mini-screw implants or transpalatal arches in adult patients with bialveolar dental protrusion. *J Oral Rehabil.* 2009;36:687–95.

15. Proffit W, Fields H. The second stage of comprehensive treatment: correction of molar relationship and space closure. In: Contemporary Orthodontics, St Louis, Mo: CV Mosby; 2000:552–575.

16. Felemban NH, Al-Sulaimani FF, Murshid ZA, Hassan AH. En masse retraction versus two-step retraction of anterior teeth in extraction treatment of bimaxillary protrusion. *J Orthod Sci.* 2013;2:28–37.

17. Kuhlberg AJ. Steps in orthodontic treatment. In: Textbook of Orthodontics Philadelphia, Pa: WB Saunders Company; 2001:240–242.

18. Xu TM, Zhang X, Oh HS, Boyd RL, Korn EL, Baumrind S. Randomized clinical trial comparing control of maxillary anchorage with 2 retraction techniques. *Am J Orthod Dentofac Orthop.* 2010;138:544.e1–e9.

19. Heo Y-Y, Cho K-C, Baek S-H. Angled-predrilling depth and mini-implant shape effects on the mechanical properties of self-drilling orthodontic mini-implants during the angled insertion procedure. *Angle Orthod.* 2012;82:881-8.

20. Ribeiro GLU, Jacob HB. Understanding the basis of space closure in orthodontics for a more efficient orthodontic treatment. *Dent Press J Orthod.* 2016;21:115–125.

21. Nanda R, Kuhlberg A, Uribe F. Biomechanic basis of extraction space closure. In: Biomechanics and Esthetic Strategies in Clinical Orthodontics. Saint Louis, Mo: Elsevier Saunders; 1997;194–210.

22. Schneider PP, Gandini Júnior LG, Monini A da C, Pinto A dos S, Kim KB. Comparison of anterior retraction and anchorage control between en masse retraction and two-step retraction: A randomized prospective clinical trial. *Angle Orthod.* 2018. Available at: http://www.angle.org/doi/10.2319/051518-363.1. Accessed December 4, 2018.

23. Fraunhofer JA von, Bonds PW, Johnson BE. Force generation by orthodontic coil springs. 1993. *Angle Orthod.1993;63:145-8.*

24. Miura F, Mogi M, Ohura Y, Karibe M. The super-elastic Japanese NiTi alloy wire for use in orthodontics. Part III. Studies on the Japanese NiTi alloy coil springs. *Am J Orthod Dentofac Orthop.*1988;94:89–96.

25. Camper P. Works on the connection between the science of anatomy and the arts of drawing, painting, statuary and etc. A quantitative method for the evaluation of the soft tissue profile. *Am J Orthod Dentofac Orthop.* 1959;45:738-751.

26. Burstone CJ. Lip posture and its significance in treatment planning. *Am J Orthod Dentofac Orthop.*1967;53:262–84.

27. Huh YJ, Huh K-H, Kim H-K, et al. Constancy of the angle between the Frankfort horizontal plane and the sella-nasion line: a nine-year longitudinal study. *Angle Orthod.* 2014;84:286–91.

28. Zierhut EC, Little RM. Long-Term Profile Changes Associated with Successfully Treated Extraction and Nonextraction Class II Division 1 Malocclusions. *Angle Orthod.* 2000;70:12.

29. Oliveira GF de, Almeida MR de, Almeida RR de, Ramos AL. Alterações dentoesqueléticas e do perfil facial em pacientes tratados ortodonticamente com extração de quatro primeiros pré-molares. *Dent Press J Orthod.* 2008;13:105–14.

30. Baccetti T, Franchi L, Mucedero M, Cozza P. Treatment and post-treatment effects of facemask therapy on the sagittal pharyngeal dimensions in Class III subjects. *Eur J Orthod.* 2010;32:346–50.

31. Nanda RS, Meng H, Kapila S, Goorhuis J. Growth changes in the soft tissue facial profile. *Angle Orthod.* 1990;60:177–90.

32. Basciftci FA, Usumez S. Effects of extraction and nonextraction treatment on class I and class II subjects. *Angle Orthod.* 2003;73:36–42.

33. Janson G, Quaglio CL, Pinzan A, Franco EJ, Freitas MR de. Craniofacial characteristics of Caucasian and Afro-Caucasian Brazilian subjects with normal occlusion. *J Appl Oral Sci.* 2011;19:118–24.

34. Parra FC, Amado RC, Lambertucci JR, Rocha J, Antunes CM, Pena SDJ. Color and genomic ancestry in Brazilians. *Proc Natl Acad Sci.* 2003;100:177–82.

35. Durso DF, Bydlowski SP, Hutz MH, Suarez-Kurtz G, Magalhães TR, Pena SDJ. Association of genetic variants with self-assessed color categories in Brazilians. *PloS One.* 2014;9:e83926.

36. Monini A da C, Gandini Júnior LG, Pinto AS, Maia LGM, Rodrigues WC. Procedures adopted by orthodontists for space closure and anchorage control. *Dent Press J Orthod.* 2013;18:86–92.

37. Sarhan OA. Sella-Nasion line revisited. *J. Oral Rehabil.* 1995;22:905–8.

38. Heo W, Nahm D-S, Baek S-H. En masse retraction and two-step retraction of maxillary anterior teeth in adult Class I women. A comparison of anchorage loss. *Angle Orthod.* 2007;77:973–8.

39. Capelozza Filho L, Machado FM de C, Ozawa TO, Cavassan A de O, Cardoso M de A. Bracket/wire play: what to expect from tipping prescription on pre-adjusted appliances. *Dent Press J Orthod.* 2012;1:85–95.

40. Creekmore TD. Dr. Thomas D. Creekmore on torque. *J Clin Orthod.* 1979;13:305–10.

41. Konstantonis D. The impact of extraction vs nonextraction treatment on soft tissue changes in Class I borderline malocclusions. *Angle Orthod.* 2011;82:209–17.

42. Elif İdil Keser, Semra Ciger, Demet Kaya. Changes in Soft-tissue Profile After Extraction and Non-extraction Openbite Treatment. *Arastima*. 2009;33:21–30.

43. Talass MF, Talass L, Baker RC. Soft-tissue profile changes resulting from retraction of maxillary incisors. *Am J Orthod Dentofac Orthop.*1987;91:385–94.

44. Stoner, MM, Lindquist, TJ, Vorhies, JM, Hanes, PA, Hapak, FM, Haynes, ET. A cephalometric evaluation of 57 cases treated by Dr. Charles H. Tweed. *Angle Orthod*. 1979;26:01–206.

45. Almeida FM de, Neves IS, Pereira TJ, Siqueira VCV de. Assessment of the nasolabial angle after orthodontic treatment with and without extraction of the first premolars. *Dent Press J Orthod.* 2008;13:51–8.

3.2 Publicação 2*

Which one closes extraction spaces faster: en masse retraction or two-step retraction? A randomized prospective clinical trial

* Artigo escrito segundo as normas bibliográficas da revista ***The Angle Orthodontist.***

Which one closes extraction spaces faster: en masse retraction or two-step retraction? A randomized prospective clinical trial.

ABSTRACT

Objectives: To compare the extraction spaces closing time between en masse (ER) and two-step retraction (TSR). **Materials and Methods:** Forty-eight patients with bimaxillary protrusion received treatment with extraction of four first premolars. All patients were randomly allocated in a 1:1 ratio to either the ER (n=24) group or the TSR (n=24) group. The main outcome was to compare the space closing time between ER and TSR; the space closing time between female and male genders were a secondary outcome. The size of the premolars were measured in the models and data were collected on clinical records in the following times: retraction start date (T1) and space closure completion date (T2). The total time to close the extraction spaces was calculated for each extracted premolar (From T1 to T2). The Kaplan Meier method and the Log-Rank test were used to compare between the groups. **Results:** The closing time of the extraction spaces showed significant differences between the ER and TSR groups. While the ER took between 12.1 and 13.8 months, the TSR took between 24.7 and 26.8 months. The TSR group showed a significant difference in relation to genders, the male patients took 5.5 months longer than the female patients to close the extraction spaces. **Conclusions:** The TSR takes between 1.8 and 2.2 times longer than ER to close the extraction spaces and it is longer in males than females.

Keywords: Treatment time; Space closure; En masse retraction; Two-step retraction.

INTRODUCTION

One of the first questions that new orthodontic patients will ask is "How long will I need to wear braces?", and many factors can influence the answer.[1–4] The treatment time for each patient will depend on the their co-operation,[5] dental and facial characteristics; as well as the orthodontist's experience and his treatment decisions.[1]

Extraction treatment plans have been linked with longer treatment times,[1–3,6] and premolars extractions are the most significant in this time variation.[4,6–9] According to Fink and Smith,[9] cases treated with four premolar extraction take longer than two premolar extraction cases.[7,9]

Two main biomechanical strategies can be used to close the extraction spaces: en masse retraction (ER) or two-step retraction (TSR). In the first step of TSR, only the canine in each quadrant is retracted. In the second step, all the incisors are retracted until the residual spaces be close.[10–14] In ER, the incisors and canines are retracted in just one step.[15]

In clinical practice, orthodontists are looking for space closing mechanics that provide good anchorage control and shorter treatment time.[13] In theory, TSR should result in less anchorage loss,[10,14] then it has been the clinical orthodontist's choice for many years.[10,13] However, some randomized clinical trials (RCT's)[14,16,17] have already shown that there is no difference in the mesial movements of the molars between ER and TSR. For the author's knowledge, the evaluation of the space closing time for retraction technique has not been adequately explored in literature among the factors that affect the total duration of orthodontic treatment[1–4] and this question still needs to be investigated. The "retraction time" was reported briefly only as secondary outcome in a few studies[14,16,17] that it showed no significant differences between the techniques. In addition, the sample of these previous studies did not differentiate Class I and Class II patients and some of them were still in the active growing phase; as well as using different types of anchorage reinforcement (miniscrews, headgear or conventional anchorage).[14,18] Despite the importance of being able to accurately predict the orthodontic treatment duration,[1–4,7–9] no RCT was found in the literature to compare the time spent for space closing with ER and TSR.

Specific objectives

The purpose of this RCT was to evaluate and to compare the time required to close the spaces of each premolar extracted between the two retraction methods, without anchoring devices. Additionally, it was to investigate whether there is difference in space closing time between male and female genders within ER and TSR.

MATERIALS AND METHODS

This RCT was approved by the Ethics Committee on Human Research of the School of São Paulo State University (ethical approval No. 01/09) (ANEXOS).

Subjects

The initial sample was recruited between February and October of 2010 and consisted of 52 participants. The inclusion criteria were: at least 18 years of age, male or female Brazilians, the presence of all permanent teeth (except third molars), Class I bimaxillary protrusion malocclusion with mild crowding in upper and lower incisors ≤ 4 mm, no previous orthodontic treatment history, good oral hygiene and no systemic diseases. Four participants were excluded due to periodontal disease or missing teeth. All selected participants had similar dental and skeletal characteristics (Table 1; Figure 1).

Table 1. Baseline skeletal and dental characteristics of subjects at pretreatment between the two groups.

Variables	ER	TSR		
	Mean (SD)	Mean (SD)	P value	Sig
SNGoMe (°)	30.6 (6.3)	27.9 (6.8)	0.166	ns
PFH/AFH (mm)	66.4 (5.0)	68.5 (6.4)	0.207	ns
PgNperp (°)	1.0 (6.7)	1.2 (8.1)	0.458	ns
Overjet (mm)	3.3 (1.3)	3.6 (1.2)	0.405	ns
Overbite (mm)	0.9 (2.0)	1.5 (1.5)	0.211	ns
L1-Apo (mm)	7.1 (2.7)	6.1 (2.6)	0.188	ns
U1-Apo (mm)	10.5 (2.4)	9.9 (3.0)	0.429	ns
FMA (°)	24.7 (5.2)	21.9 (6.8)	0.116	ns
Convexity (NA-Apo) (°)	7.1 (4.0)	6.9 (3.1)	0.817	ns
Lower Lip to E-Plane (mm)	4.5 (3.8)	3.1 (3.2)	0.159	ns

SD, standard deviation; Sig, significance; ns, not significant by the Student's *t* test at P ≤ .05.

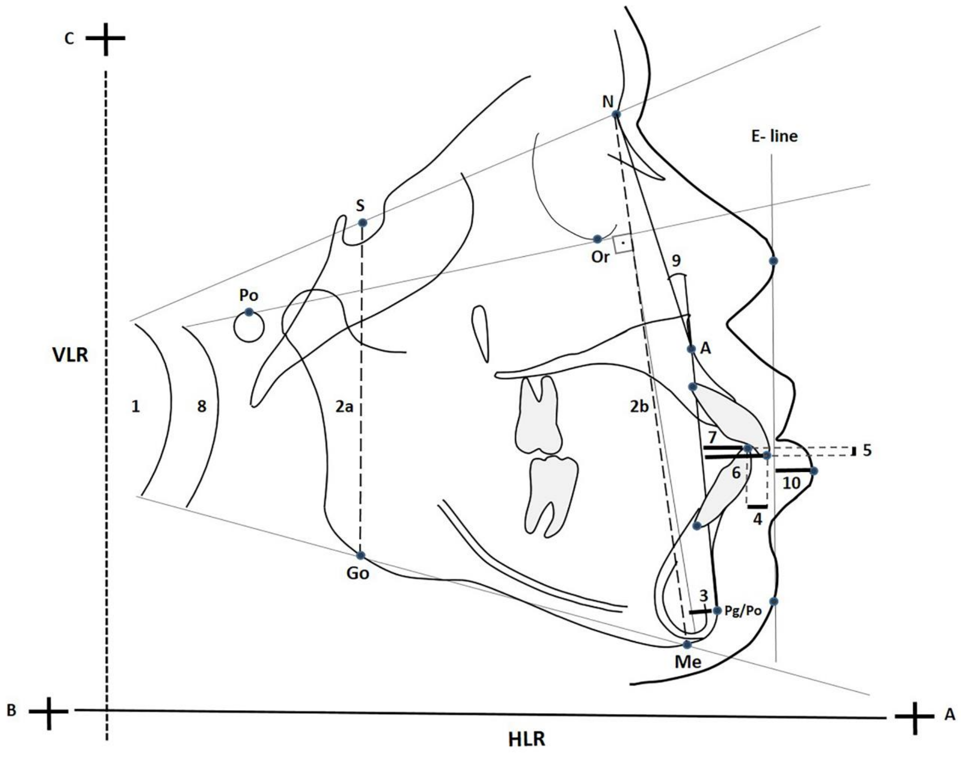

Figure 1. Cephalogram illustrating the landmarks and planes used for the study. Landmarks: 1) SNGoMe; 2) PFH/AFH; 3) PgNperp; 4) Overjet; 5) Overbite; 6) L1-Apo; 7) U1-Apo; 8) FMA; 9) NA-Apo; 10) Lower Lip to E-Plane. Points: A) Anterior reference point; B) posterior reference point; C) posterior and superior reference point. Planes: HRL and VRL.

Randomization

The participants were randomly allocated in a 1:1 ratio to either the ER group or the TSR group (Table 2) using a simple randomization technique.

Table 2. Descriptions of demographics of the two groups.

Group	n	Gender		Starting age	Age range
		Female	Male	Mean (SD) (y)	(y)
ER	24	14	10	23.9 (3.43)	19-32
TSR	24	15	9	22.0 (4.8)	18-34

SD, standard deviation; y, years.

Interventions

Initial images, models and radiographs were obtained before starting orthodontic treatment. All 48 participants received conventional orthodontic treatment with the same type of fixed appliances. Upper and lower 0.022-in tubes were soldered to bands for the first and second molars and conventional 0.022-in straight-wire brackets (Ovation-GAC, Bohemia, NY) were bonded from right second premolar to left second premolar. Leveling and aligning were conducted until 0.020-in stainless steel (SS) wire could be passively inserted into the brackets. Second premolar to second molars were tied together with 0.010” ligature wire at both sides. Each patient had the four first premolars extracted at this time. Then 7-14 days after extraction, space closing mechanics were activated.

In the ER group, all incisors were retracted in a single step. Archwires used were 0.017” X 0.025” SS and Nickel-titanium (NiTi) closed-coil springs activated to 200 gm (GAC, Bohemia, USA) were attached from the hooks of the first molars to the hooks soldered to the archwires between the lateral incisor and the canine at both sides (Figure 2A). In the TSR group, an 0.020-in SS arch wire with flush omega loops tied back to the first molars was used for the retraction of the canines. NiTi closed-coil springs activated to 100 gm were secured from the hooks of the first molars to the hooks of the canines brackets with 0.010” ligature wire (Figure 2B). After the canine retractions, the posterior were tied with teeth using 0.010” ligature wire. For the incisor retractions, 0.017”X0.025” SS wires were inserted, and NiTi closed-coil springs activated to 100gm were attached from the cervical hook of first molars to the soldered hooks located distal to the lateral incisors (Figure 2C). No auxiliary devices were used in either groups during the retractions.

The patients were evaluated every 4-5 weeks and the springs were removed, activated and checked by Correx Tension Gauge (Haag-Streit, Bern, Switzerland) to maintain the same activation until the closing of spaces were complete. All the appointments dates and clinical procedures performed on this day were correctly noted in the each patient’s clinical records, as well as their absences in the appointments and the brackets, bands or wire breaks. The patients were informed that if the appointment was forgotten, the rescheduling should be done as soon as possible, within a week. In case of breaks or loss, it should be replaced on the same day.

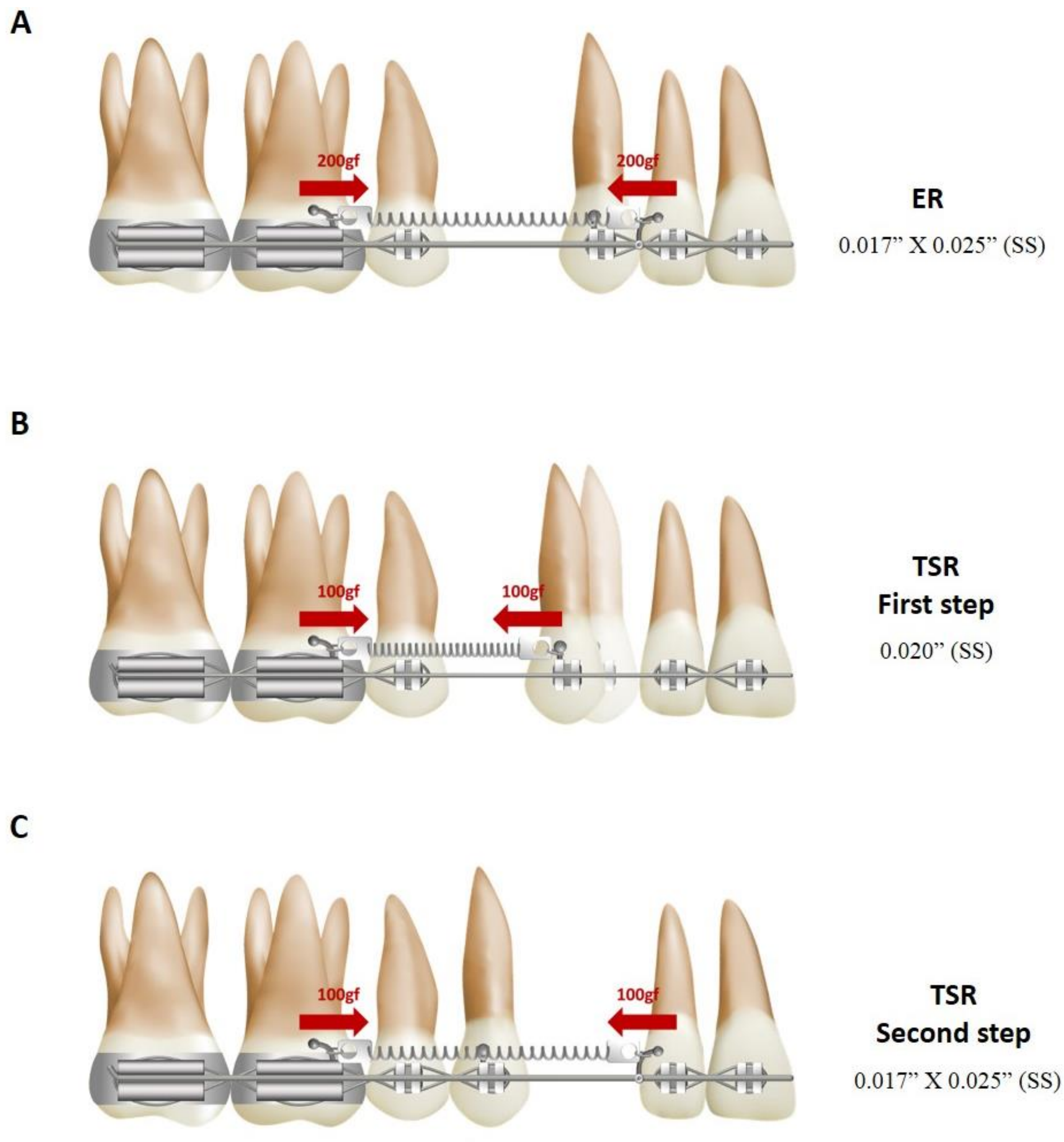

Figure 2. Illustration of ER and TSR techniques: A) ER group; B) First step at TSR group; C) Second step at TSR group.

Data collection

The principal investigator analyzed each patient' clinical records after the treatments were completed. Clinical dates were collected regarding the orthodontic procedures performed in the following times: retraction start date (T1) and spaces closure completion date (T2) for each premolar. The total retraction time (From T1 to

T2) was calculated for each premolar in months and recorded on a Microsoft Excel® spreadsheet. The size of each first premolar was measured using a digital caliper (Mitutoyo Digimatic®, Mitutoyo, UK) from the initial models.

Outcomes and any changes after trial commencement

The main outcome was to compare the closing time of spaces between ER and TSR for each premolar; the closing time of spaces for female and male genders within ER and TSR was a secondary outcome. No changes were made after trial commencement.

Interim analyses and stopping guidelines

Not applicable.

Blinding

The investigator and the patients were blinded to the allocation sequence; however, it was impossible to blind them to the treatment methods and during the collection of data.

Error of the Method

A principal investigator measured the size of first premolars. All premolars were measured twice at an interval of 4 weeks. Measurement reliability was evaluated using intraclass correlation (ICC), estimated by means of confidence intervals. The results indicated a strong intra-examiner reliability (ICC = 0.96).

Statistical methodology

Two descriptive graphics using the Kaplan-Meier method were constructed. The Kaplan-Meier curve is a descriptive analysis performed to follow what is happening with the studied event during the follow-up time.[19] In this RCT, the studied event are the "extraction space closing time with ER and TSR”. Through this statistical methodology, it is possible to obtain not only the total time for space closing with ER and TSR, but also to estimate the probability of extraction spaces which have not yet closed after in a certain period during the follow-up time.

The first descriptive Kaplan-Meier survival curve was constructed to evaluate the space closing time during ER and TSR for each premolar extracted. In this way, for both ER and TSR, the curves were constructed considering the size of the extraction spaces of all premolars (four spaces per patient) and totaling 96 extraction spaces to be closed during the follow-up time. In this curve, the horizontal axis details the follow-up time from the beginning of the retraction to the end of the space closing. The vertical axis represents the cumulative proportion (%) of the spaces that are still open for each extracted premolar. On the vertical axis the 1.0 proportion represents that 100% of the spaces have not yet closed and 0.0 proportion represents that all the spaces of the extractions have already been closed.

A second descriptive Kaplan-Meier survival curve aimed to compare extraction space closing time between genders within each group. The Log-rank test was used to compare the Kaplan-Meier survival curves. The level of significance of 5% was adopted ($\alpha = 0.05$).

RESULTS

The CONSORT diagram shows the flow of 52 participants. Four patients were excluded and 48 patients were randomly assigned between ER or TSR groups in which treatment was received and analyzed for the outcomes (Figure 3). There were no significant differences in the baseline data of the patients between groups (Table 1 and 2).

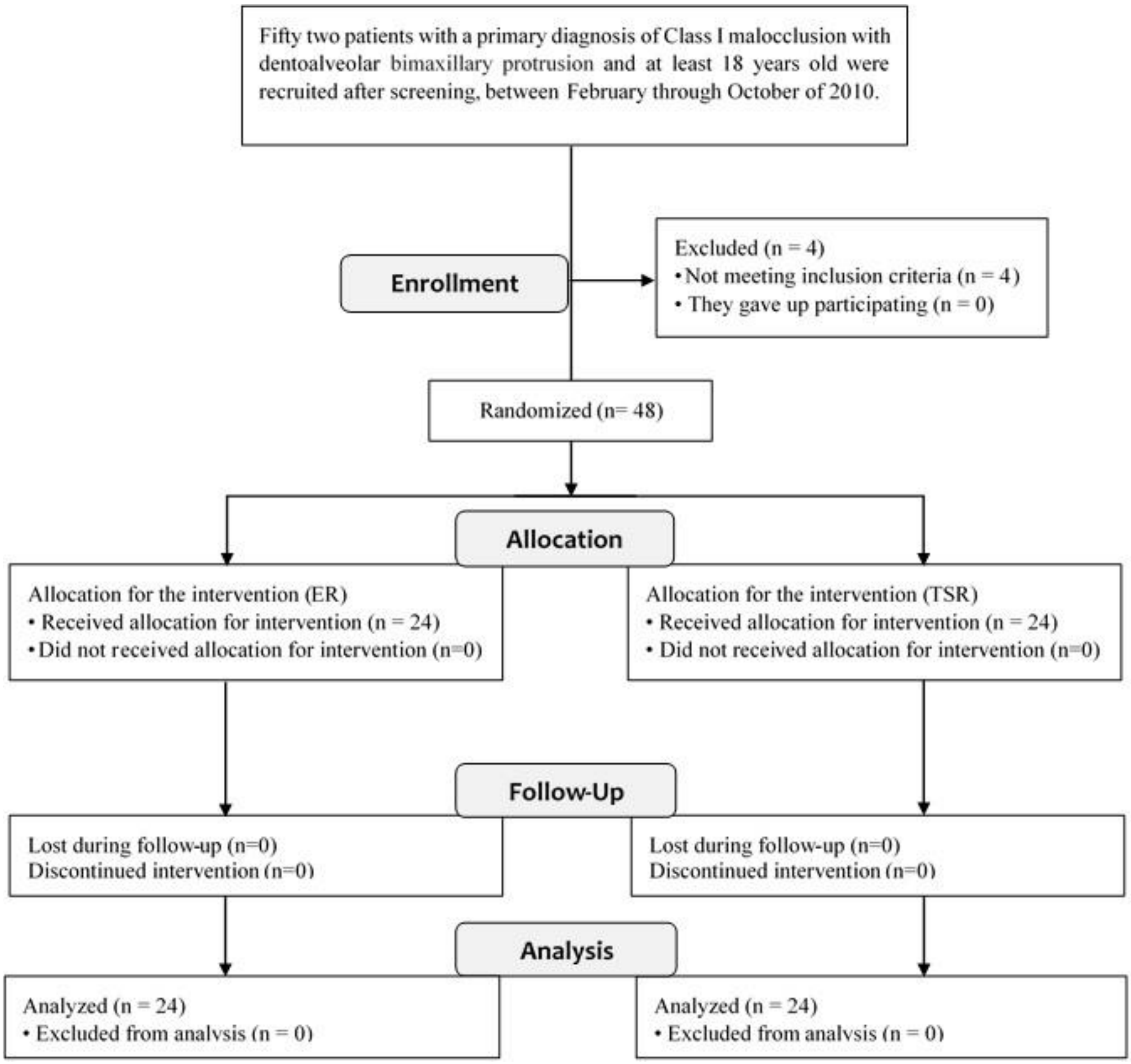

Figure 3. CONSORT flow chart showing subjects through the trial.

Numbers analyzed for each outcome, estimation and precision

Figure 4 shows the first descriptive Kaplan-Meier survival curve that represents the cumulative proportion of the extracted premolars spaces that are still open in relation to the follow-up time with ER and TSR. All extraction spaces were closed in both groups. The average of space closing time corresponds to the 0.5 proportion in Y axis, which represents the moment that 50% of the extraction spaces had not closed yet. It was around 11.0 months for the ER group and 26.0 months for the TSR group.

Table 3 shows the result of comparison of the Kaplan-Meier survival curves through the Log-Rank test. There was a significant difference in the space closing times between ER and TSR ($p < 0.001$). However, no statistically significant difference was found between the space closing times of each extracted premolar within each group ($p > 0.200$). A confident interval of 95%, determined by average ± 1.96 standard error, showed the estimation of the space closing time variation between 12.1 and 13.8 months for ER group and between 24.7 and 26.8 months for TSR group.

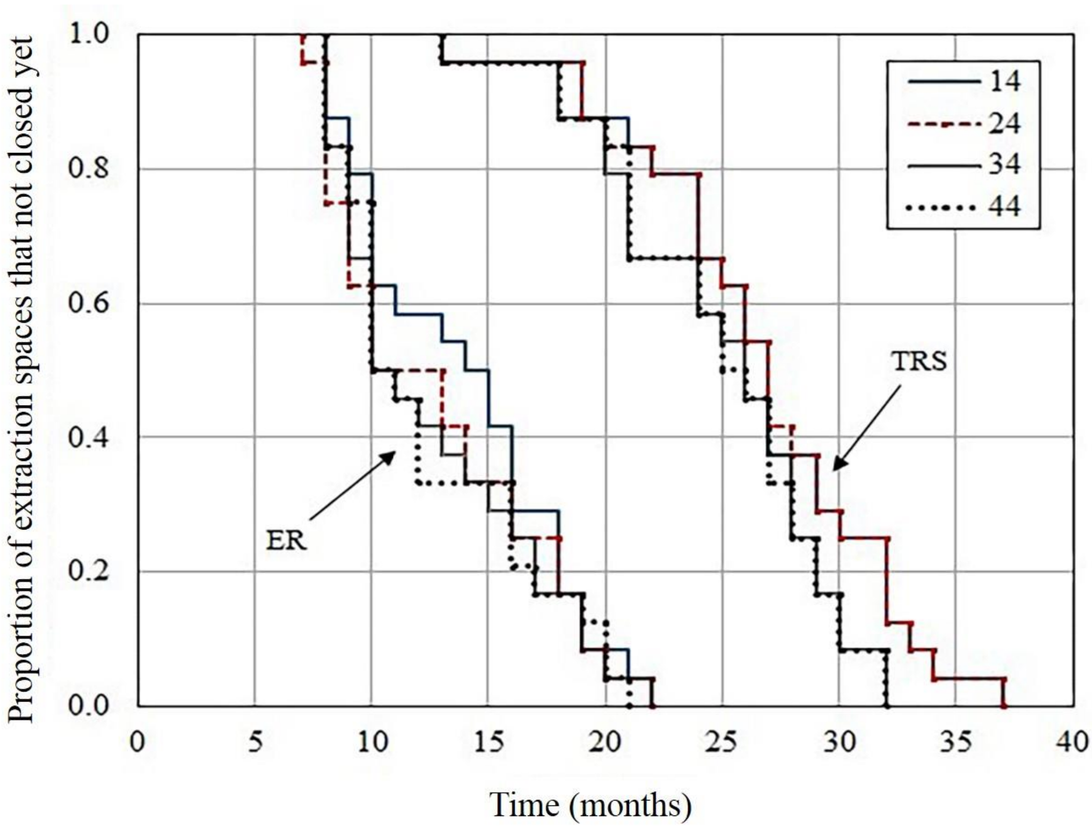

Figure 4. Descriptive Kaplan-Meier curve showing the cumulative proportion of extraction spaces that not closed yet during follow-up of time with ER and TSR groups.

Table 3. Mean, standard error (SE) of space closing time (months) for each extracted premolars between ER or TSR group.

Premolars[a]	ER		TSR		P value[b]
	n	Mean (SE)	n	Mean (SE)	
14	24	13.9 (0.9)	24	26.6 (1.1)	
24	24	12.8 (1.0)	24	26.6 (1.1)	
34	24	12.6 (0.9)	24	24.9 (1.0)	
44	24	12.6 (0.9)	24	24.8 (1.0)	
Global	96	13.0 (0.5)	96	25.7 (0.5)	<0.001 *
P value[c]		0.868		0.209	

*significant by the Log Rank test; SE, standard error.
[a] Total of 96 extracted premolar per group;
[b] Between ER and TSR groups;
[c] Between premolars within ER or TSR group.

Figure 5 shows the second descriptive Kaplan-Meier survival curve that represents the cumulative proportion of extraction spaces are not closed yet in relation to the follow-up time, subdivided by female and male genders within ER and TSR groups.

Table 4 shows that the male patients in TSR group took a significantly longer time to close the spaces. There was a significant difference between males ($p < 0.001$) and females ($p < 0.001$). In the ER group no significant difference was found in the space closing time between genders ($p = 0.353$). Within the TSR group a significant difference ($p < 0.05$) was found, with males taking longer than females.

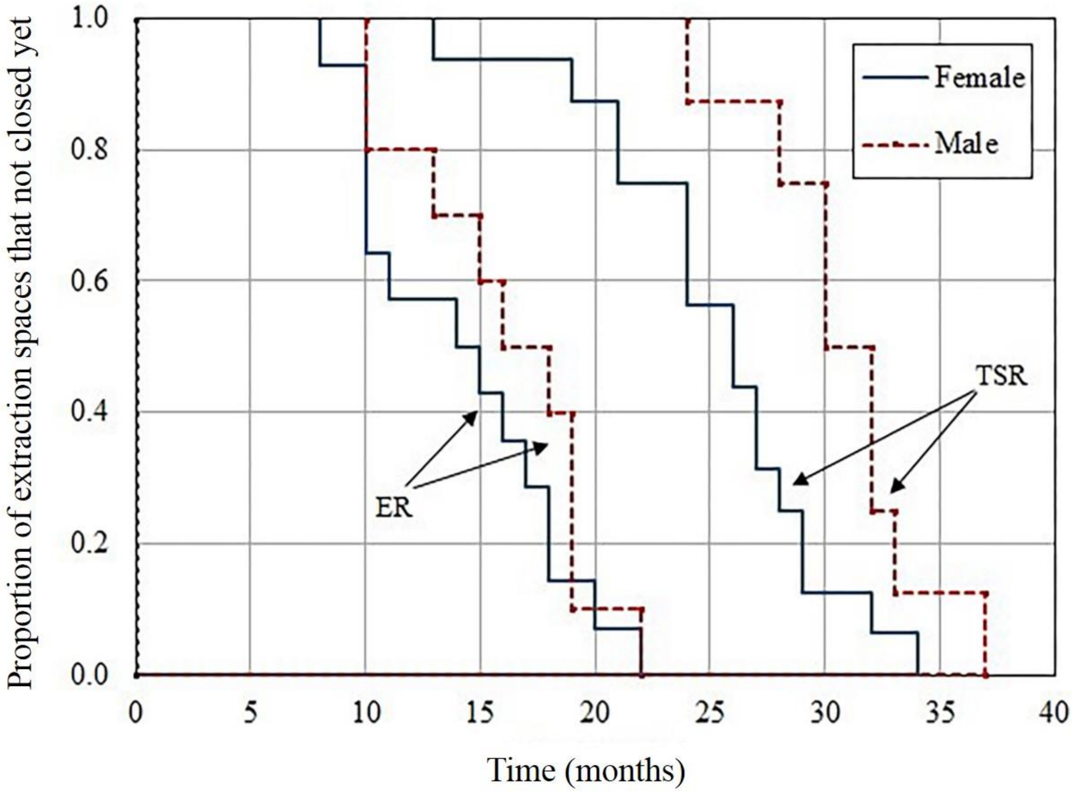

Figure 5. Descriptive Kaplan-Meier curve of cumulative proportion of extraction spaces that not closed yet during follow-up time with ER and TSR subdivided by female and male genders.

Table 4. Average of the space closing time between ER and TSR according to the gender.

Gender	ER		TSR		P value(a)
	n	Mean (DP)	n	Mean (DP)	
Female	14	14.2 (1.2)	16	25.3 (1.3)	<0.001 *
Male	10	16.1 (1.3)	8	30.8 (1.3)	<0.001 *
P value(b)		0.353		0.023*	

*significant by the Log Rank test.
[a]Between ER x TSR groups.
[b]Female x male within each ER or TSR groups.

Harms

No participant reported a negative outcome during the trial.

DISCUSSION

Previous studies have shown that both ER and TSR were efficient methods for space closing,[14,16,18] but the retraction time with each of these techniques still needed to be investigated. To date, this is the first study to shows a descriptive analysis of the spaces closing time for each premolar, since in the same patient may have each extraction space closed at different times.

The follow-up of extraction spaces closing time (Figure 4) showed that the patients started having full closure on the 7th month after the beginning of the ER while it occurred on the 13th month on the TSR. In addition, 50% extraction spaces were closed with ER by the 11th month, while the same happened for TSR patients only on the 26th month. Although the follow-up time have showed that upper premolars in TSR took longer than lower premolars, there was no significant difference in the time of space closing between the premolars intragroup.

Agreeing to the belief of the majority of orthodontics[10,13], the distance between Kaplan-Meier curves of the two groups during the follow-up time and the average value confirmed that there was statistically significant difference in the closing time of the extraction spaces between the ER and the TSR. Our results showed that the TSR took between 1.8 and 2.2 times longer than the ER to close the extraction spaces. Heo et al,[16] Xu et al,[14] and Upadhyay et al[18] also found similar results to those of our study; however, the difference in their studies was not statistically significant. One RCT was conducted[16] in adult patients without the use of additional anchorage devices, but the retraction time was evaluated only for upper premolars extraction spaces. In addition, none of these studies[14,16,18] describes in its methodology how the data collection were performed.

The gender influence on the space closing time was also examined. The results reported that there was a significant difference between female and male genders in ER and TSR. The follow-up of extraction space closing time (Figure 5) showed that in the TSR group, female patients started having full closure on the 13th month after the beginning of retraction while male patients had it started on the 24^{th} month. The male patients took 5.5 months longer to close the extraction spaces than the female patients in TSR. No significant difference was found between genders within ER group. No studies have been published yet in the orthodontic literature regarding gender differences for space closing. The only information available in the literature regarding the gender difference in treatment time is that woman are more committed to treatment than men, and the fact that the orthodontic treatment for boys takes longer.[5]

The methodology of this study was designed to produce parity between groups, excluding the influence of age, skeletal and dental characteristics within the sample. The following factors may have contributed to the time-related results:

1) The sample was limited to patients older than 18 years of age to reduce the effects that growth causes in the teeth movement. Dudic et al,[20] demonstrated that younger patients who started treatment before 16 years of age had significantly more teeth movement compared with older patients and consequently, finished orthodontic treatment in less time.

2) The treatment plan used in this study involved the alignment and leveling of all teeth with a 0.020-in SS wire before the extraction of premolars. In this way, on the date of the start retraction (T1) the initial position of the teeth were standardized, avoiding that some alignment difference could influence the movement velocity during the retraction.[13]

3) No additional anchoring devices were used. Upadhyay et al[18] demonstrated that when ER was used with miniscrews, minimum molar movements occurred during the space closing and there was decreased the retraction time.

4) Sliding mechanics with Niti springs were chosen for extraction spaces closure. Niti springs are closer to commonly used by orthodontists,[21] and their shape-memory phenomenon produces force consistency,[10,22] which remains for a long activation time.[22,23]

5) To reduce the effects in case of appliances brakes,[2,4,8] the patients should notify the orthodontist as soon as possible and have it repair performed on the same day.

The shorter retraction time with ER can be more clinically significant, particularly in view of the fact that some studies[14,16,17] showed that there is no difference in the anchorage loss during the space closing between these two retraction techniques. So the orthodontist’s classical choice for the TSR[10,13] should be reconsidered. When choosing the TSR, the canines tend to rotate and tip more than when they are retract with the incisors [10,14]and therefore, they will require additional treatment time to be realigned[14]. Additionally, TSR can be unaesthetic due to the creation of distal gaps to the lateral incisors. Besides that, the risk of external apical roots resorption are increased for longer treatment time[24]. For these reasons, ER should be considered to close the extraction spaces, unless that anterior crowding or midline discrepancy are present. In these cases, the individual canine retractions are indicated to create spaces for the retract the incisors and prevent their protrusion[13]. If more retraction of the anterior teeth is needed, then the anchorage reinforcement may be considered.

CONCLUSIONS

When comparing the closing time of the extraction spaces between en masse retraction (ER) and two-step retraction (TRS), the following were concluded:

- The ER closed the spaces faster than the TSR;
- The TSR took between 1.8 to 2.2 times longer than the ER to close the extraction spaces;
- The TSR times were significantly longer for males than females.

ACKNOWLEDGEMENTS

We thank for all the support provided from São Paulo Research Foundation (FAPESP), process nº 2015/10099-0, School of Dentistry at Araraquara (UNESP), Brazil and Center for Advanced Dental Education (CADE) at Saint Louis University, USA.

REFERENCES

1. Mavreas D, Athanasiou AE. Factors affecting the duration of orthodontic treatment: a systematic review. *Eur. J. Orthod.* 2008;30:386–95.

2. Skidmore KJ, Brook KJ, Thomson WM, Harding WJ. Factors influencing treatment time in orthodontic patients. *Am. J. Orthod. Dentofacial Orthop.* 2006;129:230–8.

3. Fisher MA, Wenger RM, Hans MG. Pretreatment characteristics associated with orthodontic treatment duration. *Am. J. Orthod. Dentofacial Orthop.* 2010;137:178–86.

4. Beckwith FR, Ackerman RJ, Cobb CM, Tira DE. An evaluation of factors affecting duration of orthodontic treatment. *Am. J. Orthod. Dentofacial Orthop.* 1999;115:439–47.

5. Starnbach HK, Kaplan A. Profile of an Excellent Orthodontic Patient. *Angle Orthod.* 1975;45:141–5.

6. Vig PS, Weintraub JA, Brown C, Kowalski CJ. The duration of orthodontic treatment with and without extractions: a pilot study of five selected practices. *Am. J. Orthod. Dentofacial Orthop.* 1990;97:45–51.

7. Janson G, Maria FRT, Barros SEC, Freitas MR de, Henriques JFC. Orthodontic treatment time in 2- and 4-premolar-extraction protocols. *Am. J. Orthod. Dentofacial Orthop.* 2006;129:666–71.

8. Vig KW, Weyant R, Vayda D, O'Brien K, Bennett E. Orthodontic process and outcome: efficacy studies--strategies for developing process and outcome measures: a new era in orthodontics. *Clin. Orthod. Res.* 1998;1:147–55.

9. Fink DF, Smith RJ. The duration of orthodontic treatment. *Am. J. Orthod. Dentofacial Orthop.* 1992;102:45–51.

10. Proffit W, Fields H. The second stage of comprehensive treatment: correction of molar relationship and space closure. In: *Contemporary Orthodontics.* Mosby; 2000.p. 552–75.

11. Felemban NH, Al-Sulaimani FF, Murshid ZA, Hassan AH. En masse retraction versus two-step retraction of anterior teeth in extraction treatment of bimaxillary protrusion. *J. Orthod. Sci.* 2013;2:28–37.

12. Kuhlberg AJ, Priebe DN. Space closure and anchorage control. *Semin Orthod*. 2001;7:42-9.

13. Nanda R, Kuhlberg A, Uribe F. Biomechanic basis of extraction space closure. In: *Biomechanics and esthetic strategies in clinical orthodontics.* Saint Louis: Elsevier Saunders; 1997.p.194–210.

14. Xu TM, Zhang X, Oh HS, Boyd RL, Korn EL, Baumrind S. Randomized clinical trial comparing control of maxillary anchorage with 2 retraction techniques. *Am J Orthod Dentofacial Orthop.* 2010;138:544-e1.

15. Bennett JC, McLaughlin RP. Controlled space closure with a preadjusted appliance system. *J. Clin. Orthod.* 1990;24:251–60.

16. Heo W, Nahm DS, Baek SH. En masse retraction and two-step retraction of maxillary anterior teeth in adult Class I women. A comparison of anchorage loss. *Angle Orthod.* 2007;77:973–8.

17. Schneider PP, Gandini Júnior LG, Monini A da C, Pinto A dos S, Kim KB. Comparison of anterior retraction and anchorage control between en masse retraction and two-step retraction: A randomized prospective clinical trial. *Angle Orthod.* 2018. Available at: http://www.angle.org/doi/10.2319/051518-363.1. Accessed December 4, 2018.

18. Upadhyay M, Yadav S, Nagaraj K, Patil S. Treatment effects of mini-implants for en-masse retraction of anterior teeth in bialveolar dental protrusion patients: a randomized controlled trial. *Am J Orthod Dentofacial Orthop.*2008;134:18-29.e1.

19. Goel MK, Khanna P, Kishore J. Understanding survival analysis: Kaplan-Meier estimate. *J. Ayurveda Res.* 2010;1:274–8.

20. Dudic A, Giannopoulou C, Kiliaridis S. Factors related to the rate of orthodontically induced tooth movement. *Am J Orthod Dentofacial Orthop.* 2013;143:616–21.

21. da Costa, AM, Gandini Júnior LG, dos Santos-Pinto A, Maia LGM, Rodrigues WC. Procedures adopted by orthodontists for space closure and anchorage control. *Dent Press J Orthod.* 2013;18:86–92.

22. Miura F, Mogi M, Ohura Y, Karibe M. The super-elastic Japanese NiTi alloy wire for use in orthodontics. Part III. Studies on the Japanese NiTi alloy coil springs. *Am J Orthod Dentofacial Orthop.*1988;94:89–96.

23. Fraunhofer JA, Bonds PW, Johnson BE. Force generation by orthodontic coil springs. *Angle Orthod.* 1993;63:145-8.

24. Casa MA, Faltin RM, Faltin K, Sander FG, Arana-Chavez VE. Root resorptions in upper first premolars after application of continuous torque moment. *J Orofac Orthop.* 2001;62:285–95.

3.3 Publicação 3*

Maxillary canine and molar movement rates during extraction space closing

* Artigo escrito segundo as normas bibliográficas da revista ***The Angle Orthodontist.***

Maxillary canines and molars movement rates during extraction space closing

ABSTRACT

Objectives: The purpose of this trial was to analyze the maxillary canine and molar movements during 7 months of first step of extraction space closing with two-step retraction (TSR). Evaluating the monthly movement rates was the second objective. **Materials and Methods:** This study included twenty-five adult patients who participated in a randomized prospective clinical trial conducted at the Department of Orthodontics at São Paulo State University (UNESP) - School of Dentistry at Araraquara, São Paulo, Brazil. All patients had bimaxillary protrusion who were planned for treatment with extraction of four first premolars. The retraction of right and left maxillary canines was accomplished using Nickel-titanium closed coil springs (100gf) secured from the hook of the first molars bands to the hook of the canines brackets on 0.020-in SS arch wire. The second premolar to the second molar were tied together with 0.010” ligature wire at both sides. Standardized oblique cephalometric radiographs at 45º were taken before the retraction (T0) and during the follow-up of extraction space closing time: on the 1st (T1), 3rd (T3), 5th (T5) and 7th (T7) month. The principal investigator traced, superimposed and digitized all maxillary cephalograms using DFPlus®. The data were analyzed descriptively and through linear regression analysis. The student t-test was used to compare the sides. The level of significance of 5% was adopted ($\alpha = 0.05$). **Results:** There were no significant differences between the right and left sides. The maxillary canines cusps were retracted 4.8mm while the maxillary molars cusps lost 2.64mm of anchorage after seven months of space closing. There were significantly greater movement rates during the 1st month of retraction at which it were 1.32mm for the canines cusps and 0.82mm for the molars cusps. After the 1st retraction month, both of them started a linear movement phase in which monthly movement rates remained constant until the end of the follow-up space closing, estimated on average of 0.58 mm for the canines cusps and 0.30 mm for the molars cusps. The vertical movements were not clinically significant. **Conclusions:** During space closing, the 1st month is the retraction period of greatest canines and molars movements. After this time, the monthly movement rates are constant until the 7th month of retraction. The canines distalize by tipping movement, with the cusps moving more than the apices, while the molars mesialize by bodily movement throughout the whole space closing process.

KEY WORDS: Retraction canine; Canine distalization; Anchorage loss; Orthodontic tooth movement; Tooth movement rate; Space closure.

INTRODUCTION

Canine retractions after the extractions of first premolars is one of the most common orthodontic procedures.[1–5,5–9] The premolar extractions and canines distalization are mainly required during the treatment of cases in which there is anterior crowding or midline discrepancy.[10] In this way, it is possible to create spaces to align or retract the incisors and therefore, prevent dental protrusion.[11]

The two-step retraction (TSR) is one of the main biomechanical strategies in cases of premolar extractions in which the canines are completely retracted individually, followed by retraction of the all incisors as if it was a single block.[10,12] This space closing technique has been the classic clinical choice for many years.[1,7,13–16] Traditionally, it has been believed that the greater number of roots in the anchorage unit (composed of the second premolar, first and second molars) are more resistant to anterior movement while just one canine root is retract[17,18], which could yield less anchorage loss.[13,18,19] To achieve this goal, the orthodontic procedure that orthodontists most commonly use is the sliding mechanics with Nickel-Titanium (NiTi) springs.[20] The choice for this procedure is because of its simplicity and effectiveness, providing more predictable force control that remains active for a long time.[20–22] However, it has been associated as the most time-consuming stage of extraction-based orthodontic treatment.[7,10,13,23,24] For this reason, knowledge about movements and monthly movement rates of the canines could be the key for the orthodontist to predict the space closing[25] and to establish individual strategies for each patient during this step of the treatment.[26]

Despite the clinical relevance of predicting the teeth velocities, the human studies that described the canine displacements using NiTi closed-coil spring[2–9] reported highly variable in the movement rates. Additionally, to date, there is no consensus in orthodontics about how the teeth can be moved most efficiently.[26,27] However, these previous studies provide insufficient information. First, the subjects were in active growing phase.[4–9] Second, the canine retraction rates were evaluated through records obtained only in two moments of treatment (initial and final).[2–4,8,9] Third, the retraction rates were calculated by dividing the amount of canine cusp displacement by the time required to complete space closing.[2–4,7–9] This means that they assumed that the teeth have the same velocity throughout the all observation period. However, results from animal studies[26,27] already had showed that this is not true and that there are different movement rates during the teeth displacements. Since the activation of the orthodontic appliance is usually performed every four weeks with frictional mechanics, the following questions come up: Are the canines and molars velocities the same throughout the extraction space closing? Does the periodontal tissues' resistance promote variations in the movement rates of these teeth?

Currently, there is just one study[5] available in literature, in which NiTi closed-coil spring was used and in which more than two assessments were realized during the follow-up time. However, this was a pilot study and miniscrews were used as anchorage device. The other studies used models[3–6,9] or lateral cephalograms[7,8] to evaluate the dental positions, which must be considered as potentially problematic.[29] To our knowledge, just one study[2] investigated the canine and molar movements using a cephalogram at 45º, which has sufficient accuracy to evaluate apical movements since it does not overlap the two sides of a patient in the same radiography.[30] Besides that, studies focused on demonstrating the canine retractions considering the issue of anchorage loss during the space closing are especially difficult to find.[2,6] So far, teeth time-movement curves have been identified just in animal studies.[26,27]

Specific objectives and hypothesi

The aim of this study was to analyze the cusp and apice movements of the canines and molars during 7 months of first step of extraction space closing with TSR. The second objective was to evaluate the monthly movement rates of these teeth. The null hypothesis was that the movements, as well as the movement rates of canines and molars were the same over time.

MATERIALS AND METHODS

This study included patients who participated in a randomized clinical trial with prospective and standardized selection, in which the treatments were conducted at the Department of Orthodontics at São Paulo State University (UNESP) – Araraquara School of Dentistry, São Paulo, Brazil. The Ethics Committee of this institution approved this research (ethical approval No. 65053917.2.0000.5416) (ANEXOS).

Participants, eligibility criteria, and setting

Twenty-five patients were selected (Table 1) according to the following criteria: male and female Brazilians, age above 18 years, Class I bimaxillary protrusion malocclusion with mild crowding in upper and lower incisors ≤ 4 mm, presence of all permanent teeth (except third molars), no previous orthodontic treatment history, healthy dentition and no systemic diseases. Subjects were excluded if they had poor oral hygiene, missing teeth, periodontal disease and dental malformation. The purpose and methods of the study were completely explained to the participants and all of them signed an informed consent form agreeing to participate of this study.

Table 1. Descriptions demographics of sample.

		Gender		Starting age	Age range
Sample	n	Female	Male	Mean (SD) (y)	(y)
	25	16	9	23.3 (5.08)	17.7-35.5

SD, Standard deviation; y, years.

Sample size calculation

Sample size was calculated using the PS: Power and Sample Size Calculation software, version 3.0.43 (Vanderbilt University, Nashville, TN) available at http://www.mc.vanderbilt.edu/prevmed/ps/index.htm. A sample size of 25 patients was calculated for a significance level of 5% and a sample power of 90%, based on estimated differences of 0.2 mm of space closing between periods and a standard deviation of 0.3 mm.[31]

Interventions

Initial orthodontic protocol

Conventional 0.022-inch straight-wire brackets (Ovation, GAC, Bohemia, NY) were bonded from the right second premolar to the left second premolar and 0.022-in tubes were soldered to bands of the first and second molars in both sides. The leveling and aligning were conducted until 0.020-in stainless steel (SS) wires could be passively inserted into the brackets. Each patient had the four first premolars extracted at this time. 7-14 days after extractions, the space closing mechanics were activated.

Closing of premolars extraction spaces

All 25 patients had orthodontic treatment with total space closing by TSR, in which the right and left canines were retracted individually at first step. The retraction was undertaken on 0.020-in SS arch wire with tight omega loops tied to the first molars on each side. From the right second premolar to the left second molars were tied together with 0.010” ligature wire and no auxiliary anchoring devices were used. NiTi closed-coil springs active in 100 gf (GAC, Bohemia, USA) were secured from the hook on the labial surface of the first molar bands to the hook of the canine brackets with the help of ligature wire (Figure 1) on both sides. The patients were evaluated every 28 days. During each appointment, the right and left springs were removed and checked by Correx Tension Gauge (Haag-Streit, Bern, Switzerland), to maintain the same activation until the complete space closing.

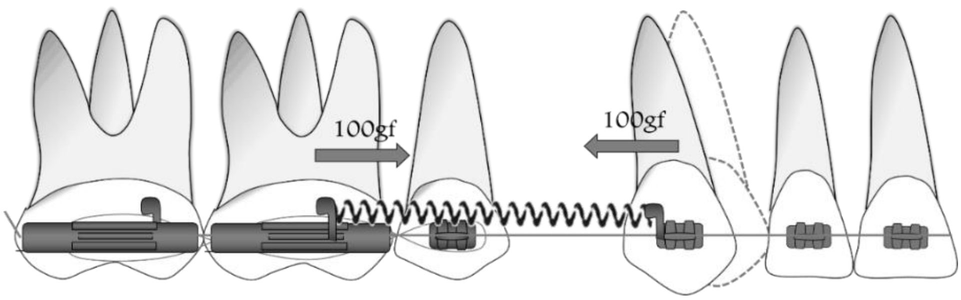

Figure 1. Individual retraction of the canine at first step of TSR.

Obtaining of the oblique cephalometric radiographs at 45º

For follow-up on the maxillary canines and molars movements during the retraction, standardized oblique cephalometric radiographs at 45º, of the right and left sides, were taken before the retraction (T0) and during the follow-up of extraction space closing time: on the 1st (T1), 3rd (T3), 5th (T5) and 7th (T7) months.

Figure 2. Image of a case showing the canine retraction on the 1st (T1), 3rd (T3), 5th (T5) and 7th (T7) month of first step of TSR.

Analysis of the oblique cephalometric cephalograms at 45º

Tracings of all radiographs were hand drawn with a 0.3-mm mechanical pencil on 0.03mm thick tracing papers (GAC International Inc.) by the principle investigator. Radiographs of the left side were traced following the same orientation of the right side. The radiograph which showed the cusps and apices more clearly was used to create individual templates of the canines and the molars for each patient of sample. No apical shortening or roots rounding were observed. After the contours of the anatomical structures, it was traced, three fiducial reference points in T0 cephalometric tracing (Figure 2). Two horizontal points were marked parallel to the functional occlusal plane, in order to determine the horizontal reference line (HRL): Point A was located in the anterior region of the tracing, and point B was located in the posterior region of the tracing. A third point, C, was marked above the orbit contour and posterior to the tracing in order to determine a vertical reference line (VRL). Two landmarks were marked on both the molar and the canine in each traced cephalogram (Figure 3).

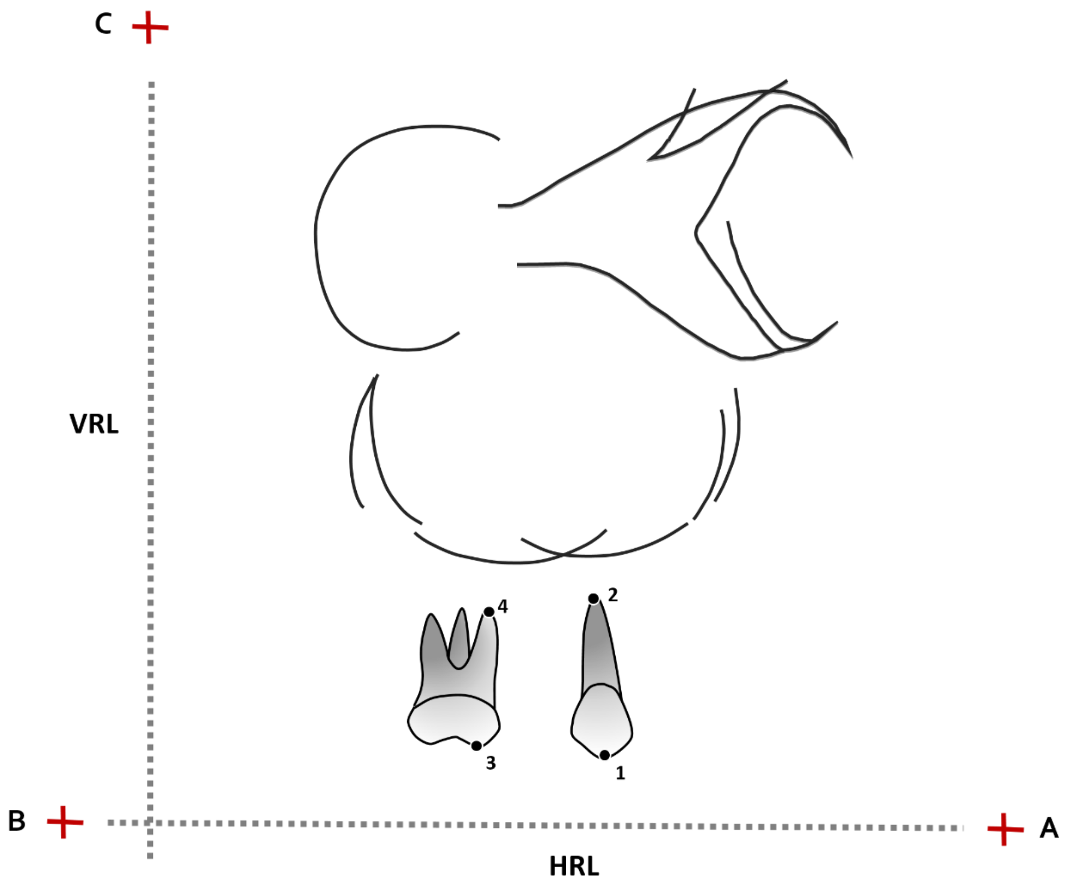

Figure 3. Cephalogram at 45º illustrating the landmarks and lines used in this analysis. Points: 1) canine cusp; 2) canine apex; 3) mesial cusp of first molar; 4) mesial apex of first molar; A) Anterior point; B) posterior point; C) superior and posterior point. Lines: HRL and VRL.

The three fiducial reference points (A, B and C) were transferred from T0 to T1 and, successively, from t0 to T3, T5 and T7 (Figure 4), using the best fit of the maxillary bone structures[30]: Inner cortical plate of the anterior part of the maxilla opposite to the canine region, posterior contour of infrazygomatic crest, nasal floor and orbital floor (Figure 4). All landmarks were digitized by the same investigator using DentoFacial Planner Plus® (DFP; version 2.0; Toronto, ON, Canada). Horizontal displacement of the cusps and apices were measured by the distance of their reference points to VLR line (Figure 4). Similarly, vertical displacements were measured from the these points to HLR (Figure 4). The values obtained were transferred to a Microsoft Excel® spreadsheet (Microsoft Office Excel 9.0, Redmond, WA, USA).

The amount of movements were measured from the origin and the movement rates were calculated for each time interval (T1-T0, T3-T1, T5-T3 and T7-T5). The subtraction of the values obtained from T7-T0 determined the total canines and molars movements over the seven months.

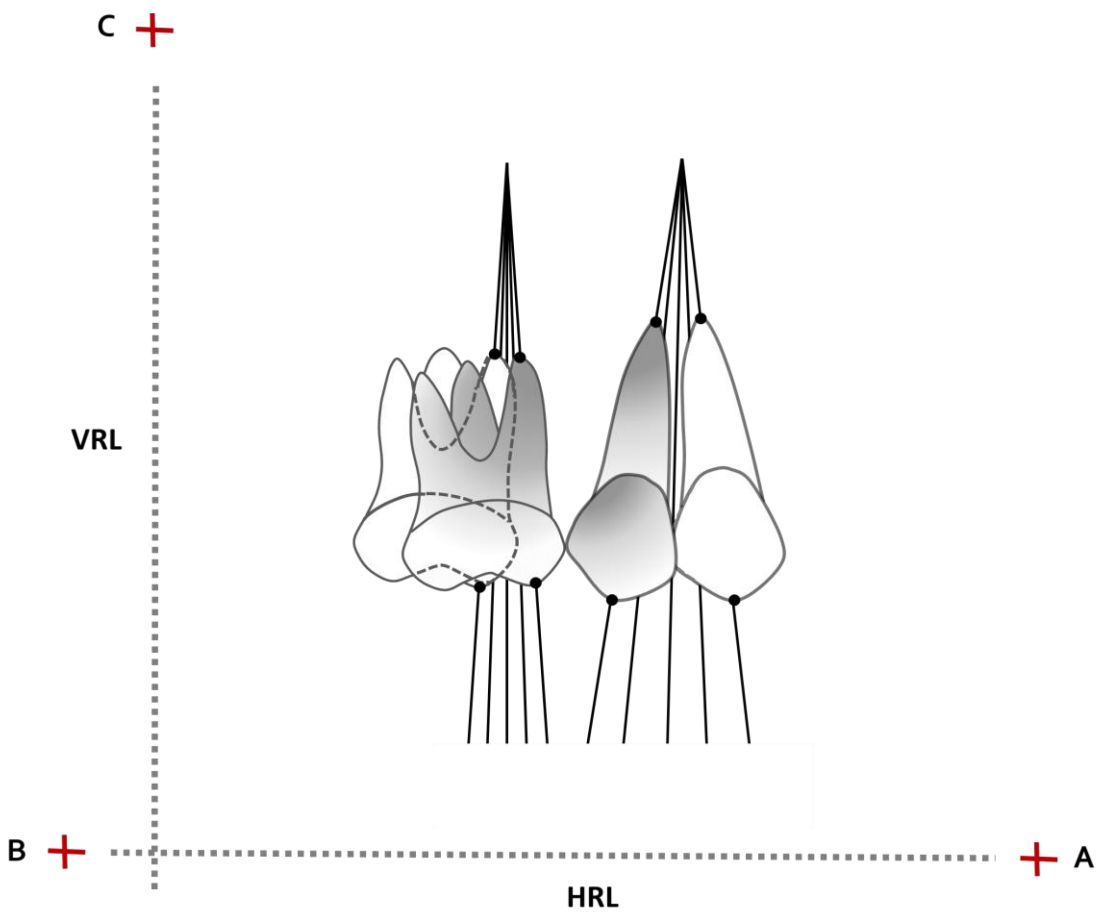

Figure 4. Superimposition of maxillary cephalograms to follow the canine and molar movements.

Blinding and error of the Method

A single-blinded investigator traced, superimposed and digitized all the radiographs. After this, 30% of the sample was traced, superimposed and digitized again at an interval of 4 weeks. Reliability was evaluated using intraclass correlation coefficients (ICCs) and estimated by means of confidence intervals. Strong intraexaminer reliability was found (ICC = 0.82).

Statistical methodology

The horizontal and vertical movements were analyzed. For this, the zero value was taken as a reference to obtain the displacement values after the 1^{st}, 3^{rd}, 5^{th} and 7^{th} month of retraction. The movement rates were also analyzed for each period (T1-T0, T3-T1, T5-T3, T7-T5). After the analysis of these data, the horizontal movements for each variable was analyzed and estimated by the linear regression model during the follow-up of canine retraction from the 1^{st} to the 7^{th} month.

The linear regression equation adopted was **Y = ax + b**. In this model, Y is the horizontal movement in millimeters (mm) and **x = (T-1)** is the follow-up time (T), in months, minus the 1^{st} month. Two coefficient lines were adopted in this equation: **"a"** which represents the estimated movement rates per month and **"b"** which is the estimate of average movement during the 1^{st} month of retraction. Confidence Intervals (CI) of 95% were also calculated. The lack of adjustment test was performed to evaluate the adequacy of the regression line at the experimental model. The adjustment quality was also determined by the coefficient of determination (R^2), which establishes the variation percentage (%) of the data that are explained by the linear regression model. In this case, there is a maximum value that is not 100% able to be explained by the R^2, since another part of the variation (%) is due to the individual variation of the 25 individuals. A Student's t-test was used to compare the variables between the right and left sides. The level of significance of 5% was adopted ($\alpha = 0.05$).

RESULTS

A Student's t-test showed that there was no significant difference ($P>0.30$) between sides. In this way, the results for the canine and molar movements of right and left sides were grouped by the average.

Descriptive analysis of horizontal movements

Table 2, Figure 5 and Figure 6 describe the average of horizontal total movement of the cusps and apices of both the canines and the molars during the follow-up of first step of space closing with TSR, from the zero until the end of the 7th retraction month.

Table 2. Mean and standard deviations (SD) of the canines and the molars from the beginning to the end of horizontal movement.

		Follow-up time			
		T1	T3	T5	T7
Variable		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Canines	Cusps, mm	1.32 (0.52)	2.56 (0.58)	3.79 (0.57)	4.80 (0.43)
	Apices, mm	0.81 (0.43)	1.43 (0.54)	2.04 (0.56)	2.78 (0.37)
Molars	Cusps, mm	0.82 (0.26)	1.56 (0.30)	2.13 (0.39)	2.64 (0.27)
	Apices, mm	0.61 (0.21)	1.31 (0.29)	1.79 (0.42)	2.17 (0.38)

Positive values indicate distal movement of the canines and mesial movement of the molars.

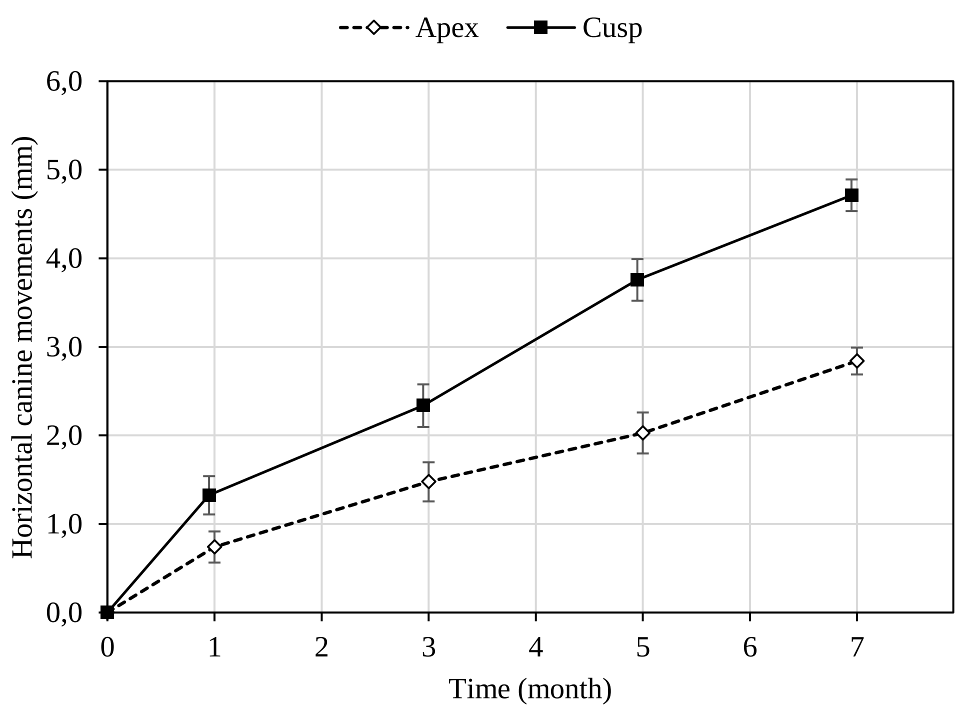

Figure 5. Descriptive time-movement curves of canines showing the horizontal movement during the follow-up time.

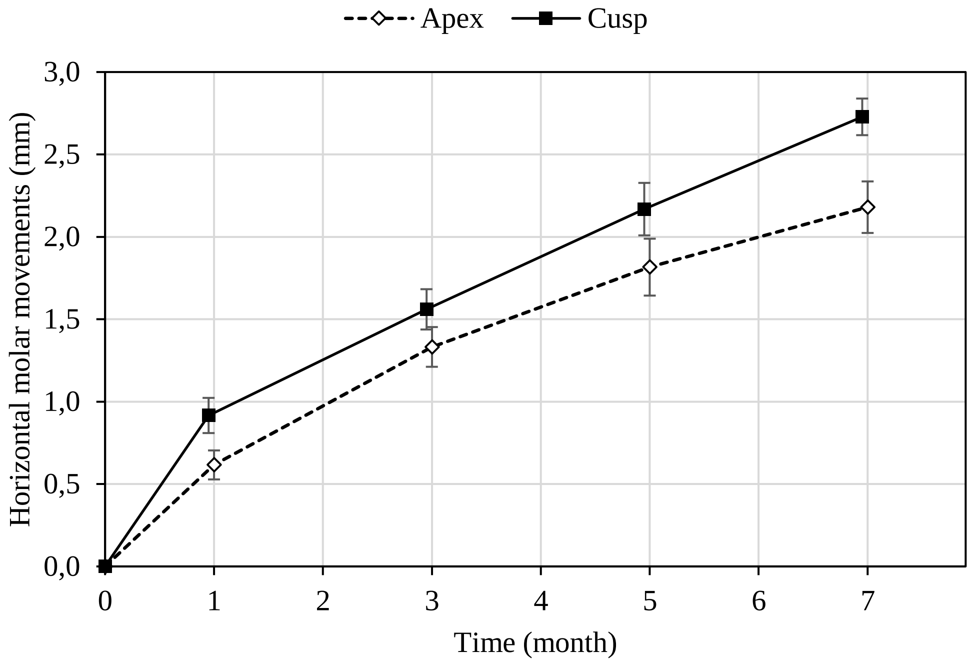

Figure 6. Descriptive time-movement curves of molars showing the horizontal movement during the follow-up time.

Descriptive analysis of vertical movements

Table 3, Figure 7 and Figure 8 describe the average vertical movement of the cusps and the apices of both the canines and molars during the follow-up of first step of space closing with TSR, from the zero until the end of the 7th retraction month.

Table 3. Mean and standard deviations (SD) of vertical teeth movement.

		Follow-up time			
		T1	T3	T5	T7
Variable		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Canines	Cusps, mm	-0.19 (0.17)	-0.16 (0.27)	-0.16 (0.32)	-0.14 (0.32)
	Apices, mm	-0.19 (0.13)	-0.24 (0.23)	-0.24 (0.25)	-0.30 (0.31)
Molars	Cusps, mm	-0.04 (0.16)	-0.05 (0.22)	-0.10 (0.28)	-0.08 (0.24)
	Apices, mm	-0.05 (0.16)	-0.07 (0.18)	-0.14 (0.29)	-0.15 (0.27)

Negative values indicate extrusion movement.

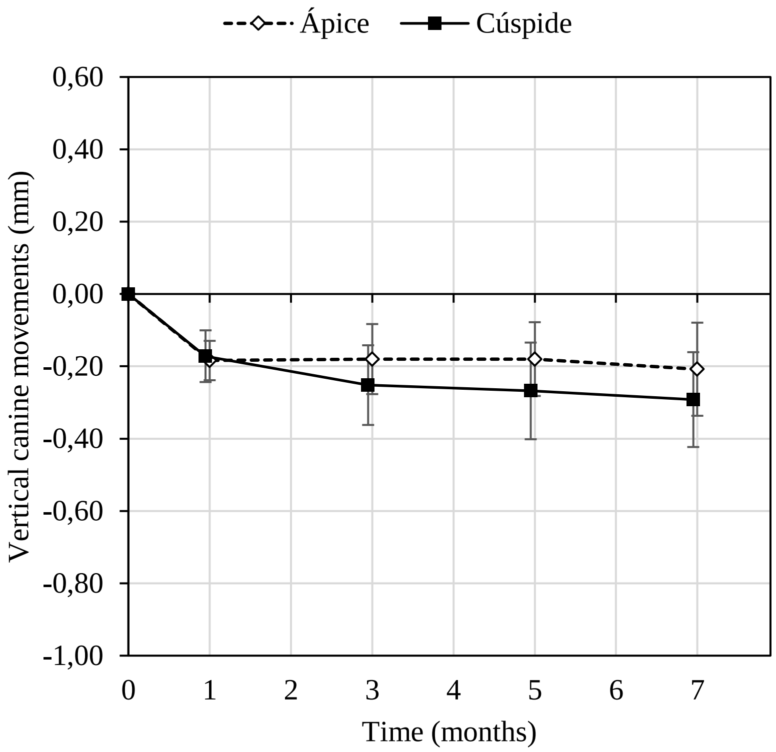

Figure 7. Descriptive time-movement curves of the canines showing the vertical movement during the follow-up time.

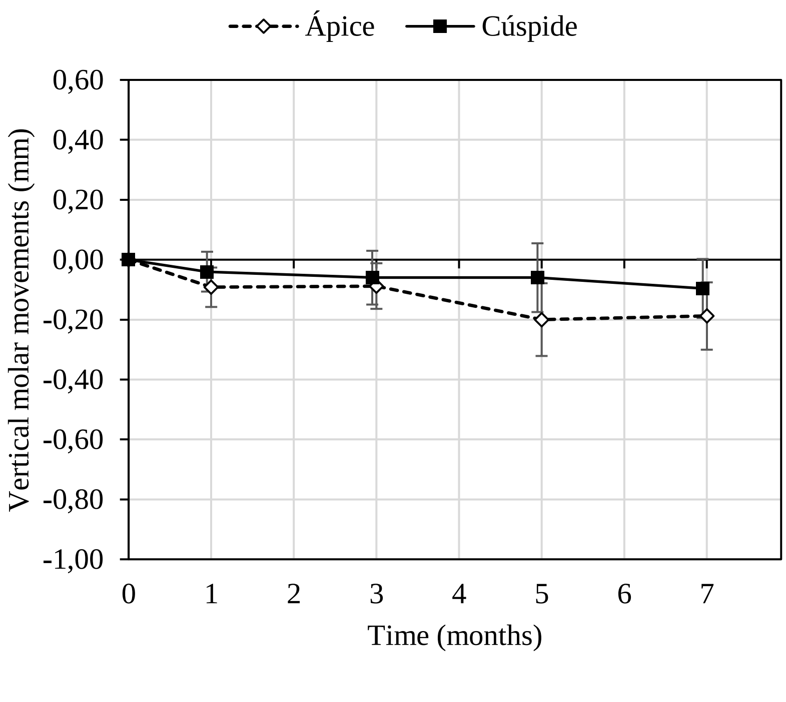

Figure 8. Descriptive time-movement curves of the molars showing the vertical movement during the follow-up time.

Descriptive analysis of horizontal movement rates

Table 4 describes the horizontal movement rates for each period. The periods (T1-T0; T3-T1; T5-T3; T7-T5) were divided by 2 to allow for monthly comparison.

Table 4. Mean, standard deviations (SD) of horizontal movement rates per month.

		Follow-up time			
		T1	T3	T5	T7
Variable		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Canines	Cusps, mm	1.32 (0.52)	0.62 (0.24)	0.62 (0.30)	0.51 (0.20)
	Apices, mm	0.81 (0.43)	0.31 (0.18)	0.31 (0.17)	0.37 (0.23)
Molars	Cusps, mm	0.82 (0.26)	0.37 (0.16)	0.28 (0.12)	0.26 (0.13)
	Apices, mm	0.61 (0.21)	0.35 (0.13)	0.24 (0.12)	0.19 (0.10)

Linear regression analysis

The canine and molar movement rates during the 1st to the 7th retraction month (Table 4) remained very similar during these periods. Therefore, it justified the application of the linear regression model to estimate not only the movement and the movement rate obtained during the evaluation period of this study, but also monthly during the for entire follow-up time.

Figures 9 and 10 show the linear regression lines for the average movement (Y) of the cusps and apices, according to the month of retraction between the 1st and the 7th month. Confidence intervals of 95% were presented on the regression lines to show the population means.

Table 5 shows the statistics derived from the linear regression model for use of the adopted linear equation. It should be noted that there was no evidence of a "lack of fit" of the regression lines, confirmed by the estimate of the Standard Deviation (SD) and by the coefficient of determination (R^2), which was always close to the maximum variation demonstrated by the line.

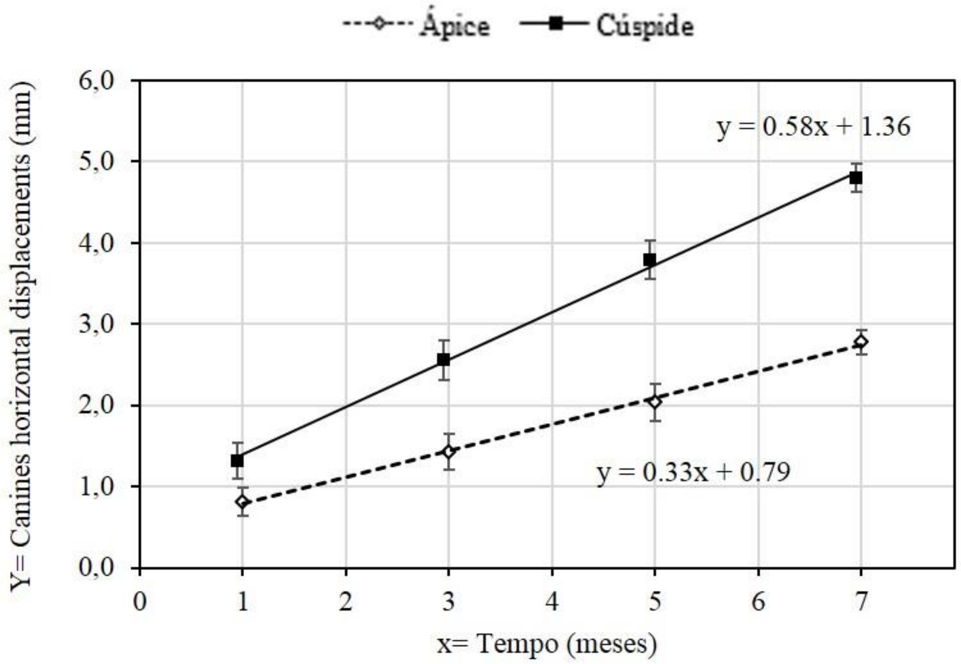

Figure 9. Linear regression model to estimate the monthly horizontal movement (Y) of the cusps and apices of the canines from the 1st to 7th retraction month.

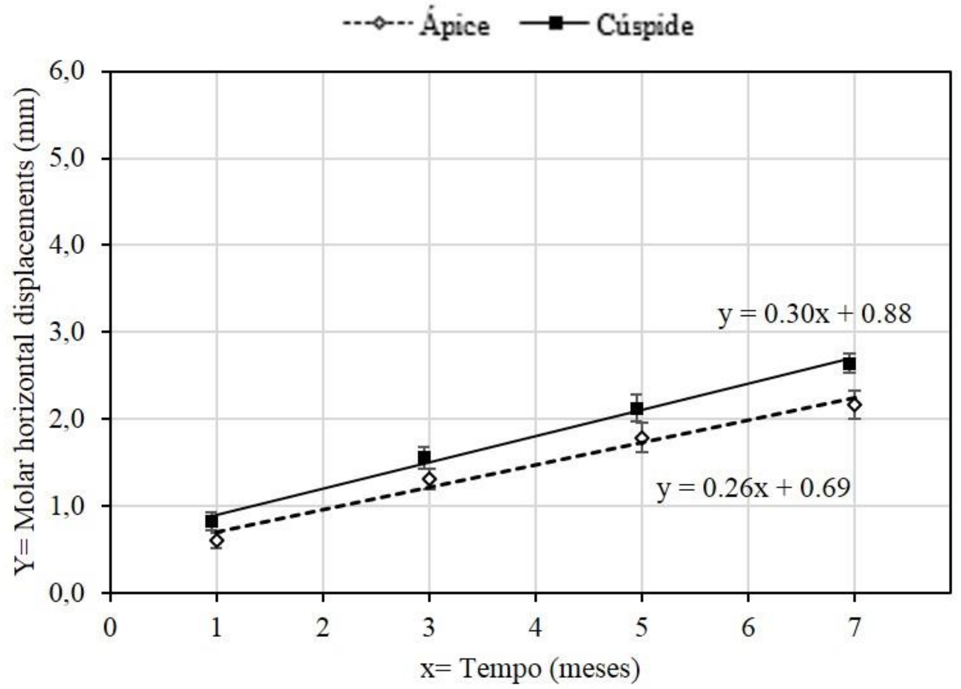

Figure 10. Linear regression model to estimate the monthly horizontal movement (Y) of the cusps and apices of the molars from the 1st to 7th retraction month.

Table 5. Statistics of the linear regression model: **Y = ax + b** , where **X = (T-1)** during 1≤T≤7 retraction months.

Variable		Line Coefficients	Estimate	CI (95%)		SD	R^2 (Max)
				IL	UL		
Canines	Cusps	*a*	0.58	0.54	0.63	0.529	86.2 (86.4)
		b	1.36	1.19	1.54		
	Apices	*a*	0.33	0.28	0.37	0.475	70.5 (70.7)
		b	0.79	0.63	0.95		
Molars	Cusps	*a*	0.30	0.27	0.33	0.309	82.9 (83.5)
		b	0.88	0.78	0.99		
	Apices	*a*	0.26	0.23	0.29	0.341	74.4 (75.8)
		b	0.69	0.58	0.81		

Line Coefficients: a, the estimate movement rates per month; b, the average movement estimate during the 1st month of retraction; CI, Confidence interval of 95% ; IL, Inferior Limit and UL, Upper Limit; SD, Standard Deviation; R^2, Coefficient of determination (%); Max, Maximum explainable by the line (%).

DISCUSSION

The time-movement curves in the horizontal direction (Figures 5 and 6) and the results reported in Table 2 showed that the canines and molars always responded to the activation of the orthodontic appliance with their cusps and apices displacements. However, it was possible to visualize during the follow-up that the 1st month of retraction was the greatest movement. The average of canines cusps retraction was 1.32 mm, with the apices retracting 0.81 mm. For the molars, the mesial displacement was 0.82 mm for the cusps and 0.61 mm for the apices. The values found are compatible with the biologically acceptable tooth movement that is estimated between 1mm and 1.5 mm per month[26]. Since the movement rates can be influenced by the type of movements,[17,28] the possible explanation for the initial acceleration in the first stage it is the immediate canine tipping in its alveolus, when the NiTi closed-coil spring mechanics was active. In this way, it may had generated more compression at periodontal ligament and more deformation in the alveolar bone crest.[26]

After the 1st month, the canine and molar monthly movement rates were constant until the 7th retraction month, at which they started a linear movement phase.

This means that, in this second stage, once teeth movement started, bone remodeling and periodontal ligament turnover took place at a more constant rate.[26,27] The canine retraction rates estimated in the linear model were, on average, 0.58 mm for the cusps and 0.33 mm for the apices while for the molars were, respectively, 0.30 mm and 0.26 mm. A large variability for the mean canine movement rates, which ranges from 0.21 mm to 1.91 mm, is evidenced in table 6. To date, just one study[6] reported monthly anchorage loss rates of the molars, which was approximately 0.5 mm for both the cusps and apices. However, this finding cannot be directly compared because this study used transpalatal arches and the patients were still actively growing.

Obviously, many biological factors can have influence on the variation for the movement velocities available in literature, such as: alveolar bone density,[32] the ability of periodontal cells to react to the mechanical stimuli[33] and the formation of hyalinized tissue during the movement.[27,33,34]

The methodology of this study was carefully designed to reduce many of the variables that could have an adversely effect in the veracity of the results. Thus, the current findings may have been influenced by:

1) The sample was composed of only adult patients, since actively growing patients showed faster tooth movement velocity than those who were no longer growing.[24,32,34–36]

2) The crowding was quantified during sample selection. Geron et al.[37] reported that the anchorage loss is a multifactorial response that is primarily affected by the amount of crowding.

3) The treatment plan used in this study involved the alignment and leveling of all teeth with a 0.020-in (SS) wire before first premolars were extracted. This step standardized the initial teeth position before they were retracted, since that differences in the teeth alignment could influence the movement speed during the sliding retraction.[15]

4) The space closure started just 7-14 days after the extraction of the premolars. Hasler et al.[16] showed that the teeth movement into recent extraction sites is faster than into healed sites.

5) A force of 100 gf was chosen for the individual canine retraction. There is no consensus in literature about the optimal force levels to provide canine distillation[14] and a wide variety in force magnitude has been used for retraction in previous studies

(Table 6). However, Quinn and Yoshikawa[38] surmised that a force between 100gf and 200gf would be most efficient for canine retraction.

6) Only dental anchoring of the posterior teeth was used in this study. Previous studies[24,39,40] have shown that when the retraction was associated with anchoring devices, such as miniscrews, the molars showed minimal movement and there was a decreased of retraction time.

7) A calculation was not performed to determine the average of movement rate. The assessments period of our study was higher than previous studies, which allowed the application of the linear regression model. Thus, it was possible to estimate the movement for any month during the follow-up time and not only suppose that it would be the same during all months as previous studies.[2-9]

8) The coefficient of determination (R^2) was extremely high for all variables. This means that the linear regression model explains very well what happens during the space closing, since another part of the variation (%) is due to the individual variations of the 25 individuals. This is in agreement with the report of previous studies[2,6,17,26,27,32,34] in which the variation in the biological response among subjects appears to be one of the greater deciding factors for determining teeth movement rates.

The time-movement curves in the vertical direction (Figures 7 and 8) and the results reported in Table 3 indicated minimal apical extrusive movement of less than 0.3 mm, what means that the canines and molars maintained their vertical position during the space closing. This value is considered too small to be clinically significant since it did not compromise the treatment results. In this way, it would not be justifiable to creating a linear regression analysis.

After 7 months of continued retraction, the results showed that the canines distalize by tipping movements, with the cusps moved 2mm more than the apices, while the molars move by bodily movement. The lines of action of force produced by the NiTi springs were occlusal and buccal from the resistance center of the teeth. It was to be expected that moments were produced resulting in rotation and in inclination of the canines in the direction of the force.[10,28] At the end of the retraction, the maxillary canine cusps retracted 4.8 mm while the maxillary molar cusps lost 2.64 mm of anchorage. This means that the dental anchorage unit, composed by the roots of the second premolar, first and second molars, advanced 35.4% of extraction spaces during the individual canines retraction. The ratio of canine retractions to the mean anchorage loss was approximately 0.94:1.

The results of this study challenge many orthodontists' beliefs: that individual canine retraction are more effective in preventing anchorage loss. The tipping and the risk of anchorage loss during individual canine retractions are undesirable side-effects which should be considered during orthodontic treatment planning.

CONCLUSION

When the maxillary canine and molar movement rates were analyzed during the first step of two-step retraction (TSR), the following were concluded:

- The 1st retraction month is the period of greatest movements of canines and molars.
- The monthly movement rates of canines and molars are constant from the 1st to the 7th month of retraction.
- The canines tipping, with the cusps moving more than the apices, while the molars move by bodily movement.

Table 6. Human studies on maxillary canine and molar movement rates with frictional mechanics (NiTi closed-coil spring).

Author	Sample size/ Range of age (y)	Spaces closure mechanic	Magnitude Force	Canines movement rates (mm/month)	Molars movement rates (mm/month)	Method
Dixon et al.[9]	33/10 to 18	Active ligatures	-	0.35	N/A	Models
		Powerchain	-	0.58		
		NiTi closed-coil spring	200gf	0.81		
Nightingale and Jones.[4]	8/12 to 18	Elastomeric chain	209-109gf	0.21	N/A	Models
		NiTi closed-coil spring	300-149gf	0.26		
Hayashi et al.[3]	8/19.4 to 29.2	NiTi closed-coil spring	100gf	1.41	N/A	Models
		Ricketts spring	100gf	1.91		
Bokas and Woods.[6]	12/13 to 14.5	NiTi closed-coil spring	200gf	1.85	0.46	Models
		Power chain	-	1.68	0.45	
Herman et al. [5]	16/11.4 to 22.6	NiTi closed-coil spring	150gf	1.3 (MA)	N/A	Models
Thiruvenkatachari et al.[7]	10/16 to 20	NiTi closed-coil spring	100gf	0.93 (MA) 0.81 (CA)	N/A	Lateral Cephalogram
Oz et al. [8]	19/12.7 to 15.3	NiTi closed-coil spring	200gf	0.91 (SLB) 0.85 (MT)	N/A	Lateral Cephalogram
Monini et al.[2]	25/17 to 35	NiTi closed-coil spring	100gf	0.71 (SLB) 0.72 (CB)	N/A	Cephalogram at 45º

N/A, Information not available; y, years; MA, Miniscrews Anchorage; CA, Conventional Anchorage; SLB, Self-ligation Bracket; CB, Conventional Bracket.

REFERENCES

1. Ziegler P, Ingervall B. A clinical study of maxillary canine retraction with a retraction spring and with sliding mechanics. *Am J Orthod Dentofacial Orthop.* 1989;95:99–106.

2. da Costa Monini A, Gandini Júnior LG, Martins RP, Vianna AP. Canine retraction and anchorage loss: self-ligating versus conventional brackets in a randomized split-mouth study. *Angle Orthod*. 2014;84:846–52.

3. Hayashi K, Uechi J, Murata M, Mizoguchi I. Comparison of maxillary canine retraction with sliding mechanics and a retraction spring: a three-dimensional analysis based on a midpalatal orthodontic implant. *Eur J Orthod.* 2004;26:585–9.

4. Nightingale C, Jones SP. A clinical investigation of force delivery systems for orthodontic space closure. *J Orthod.* 2003;30:229–36.

5. Herman RJ, Currier GF, Miyake A. Mini-implant anchorage for maxillary canine retraction: a pilot study. *Am J Orthod Dentofacial Orthop.* 2006;130:228–35.

6. Bokas J, Woods M. A clinical comparison between nickel titanium springs and elastomeric chains. *Aust Orthod J.* 2006;22:39–46.

7. Thiruvenkatachari B, Ammayappan P, Kandaswamy R. Comparison of rate of canine retraction with conventional molar anchorage and titanium implant anchorage. *Am J Orthod Dentofacial Orthop.* 2008;134:30–5.

8. Oz AA, Arici N, Arici S. The clinical and laboratory effects of bracket type during canine distalization with sliding mechanics. *Angle Orthod.* 2012;82:326–32.

9. Dixon V, Read MJF, O'Brien KD, Worthington HV, Mandall NA. A randomized clinical trial to compare three methods of orthodontic space closure. *J Orthod.* 2002;29:31–6.

10. Ribeiro GLU, Jacob HB. Understanding the basis of space closure in Orthodontics for a more efficient orthodontic treatment. *Dental Press J Orthod.* 2016;21:115–25.

11. Casa MA, Faltin RM, Faltin K, Sander FG, Arana-Chavez VE. Root resorptions in upper first premolars after application of continuous torque moment. Intra-individual study. *J Orofac Orthop.* 2001;62:285–95.

12. Felemban NH, Al-Sulaimani FF, Murshid ZA, Hassan AH. En masse retraction versus two-step retraction of anterior teeth in extraction treatment of bimaxillary protrusion. *J Orthod Sci.* 2013;2:28–37.

13. Proffit W, Fields H. The second stage of comprehensive treatment: correction of molar relationship and space closure. In: Contemporary Orthodontics, St Louis, Mo: CV Mosby; 2000:552–575.

14. Kulshrestha RS, Tandon R, Chandra P. Canine retraction: A systematic review of different methods used. *J Orthod Sci.* 2015;4:1–8.

15. Nanda R, Kuhlberg A, Uribe F. Biomechanic basis of extraction space closure. In: Biomechanics and Esthetic Strategies in Clinical Orthodontics. Saint Louis, Mo: Elsevier Saunders; 1997;194–210.

16. Häsler R, Schmid G, Ingervall B, Gebauer U. A clinical comparison of the rate of maxillary canine retraction into healed and recent extraction sites--a pilot study. *Eur J Orthod.* 1997;19:711–9.

17. Hixon EH, Aasen TO, Arango J, et al. On force and tooth movement. *Am J Orthod Dentofacial Orthop.* 1970;57:476–89.

18. Hart A, Taft L, Greenberg SN. The effectiveness of differential moments in establishing and maintaining anchorage. *Am J Orthod Dentofacial Orthop.* 1992;102:434–42.

19. Bennett JC, McLaughlin RP. Controlled space closure with a preadjusted appliance system. *J Clin Orthod.* 1990;24:251–60.

20. Monini A da C, Gandini Júnior LG, Pinto AS, Maia LGM, Rodrigues WC. Procedures adopted by orthodontists for space closure and anchorage control. *Dental Press J Orthod.* 2013;18:86–92.

21. Miura F, Mogi M, Ohura Y, Karibe M. The super-elastic Japanese NiTi alloy wire for use in orthodontics part III. Studies on the Japanese NiTi alloy coil springs. *Am J Orthod Dentofacial Orthop.*1988;94:89–96.

22. Fraunhofer JA von, Bonds PW, Johnson BE. Force generation by orthodontic coil springs. *Angle Orthod*. 1993;63:145-8.

23. Shpack N, Davidovitch M, Sarne O, Panayi N, Vardimon AD. Duration and anchorage management of canine retraction with bodily versus tipping mechanics. *Angle Orthod.* 2008;78:95–100.

24. Xu TM, Zhang X, Oh HS, Boyd RL, Korn EL, Baumrind S. Randomized clinical trial comparing control of maxillary anchorage with 2 retraction techniques. *Am J Orthod Dentofac Orthop.* 2010;138:544.e1–e9.

25. Mavreas D, Athanasiou AE. Factors affecting the duration of orthodontic treatment: a systematic review. *Eur J Orthod.* 2008;30:386–95.

26. Pilon JJGM, Kuijpers-Jagtman AM, Maltha JC. Magnitude of orthodontic forces and rate of bodily tooth movement. An experimental study. *Am J Orthod Dentofacial Orthop*. 1996;110:16–23.

27. Van Leeuwen EJ, Maltha JC, Kuijpers-Jagtman AM. Tooth movement with light continuous and discontinuous forces in beagle dogs. *Eur J Oral Sci.* 1999;107:468–74.

28. Barlow M, Kula K. Factors influencing efficiency of sliding mechanics to close extraction space: a systematic review. *Orthod Craniofac Res.* 2008;11:65–73.

29. Martins RP, Buschang PH, Gandini LG, Rossouw PE. Changes over time in canine retraction: an implant study. *Am J Orthod Dentofacial Orthop.* 2009;136:87–93.

30. Sakima MT, Sakima CGP, Melsen B. The validity of superimposing oblique cephalometric radiographs to assess tooth movement: an implant study. *Am J Orthod Dentofacial Orthop.* 2004;126:344–53.

31. Mezomo M, de Lima ES, de Menezes LM, Weissheimer A, Allgayer S. Maxillary canine retraction with self-ligating and conventional brackets. *The Angle Orthodontist.* 2011;81:292–7.

32. Dudic A, Giannopoulou C, Meda P, Montet X, Kiliaridis S. Orthodontically induced cervical root resorption in humans is associated with the amount of tooth movement. *Eur J Orthod*. 2017;39:534–40.

33. Von Böhl M, Kuijpers-Jagtman AM. Hyalinization during orthodontic tooth movement: a systematic review on tissue reactions. *Eur J Orthod.* 2009;31:30–6.

34. Reitan K. Clinical and histologic observations on tooth movement during and after orthodontic treatment. *Am J Orthod Dentofacial Orthop.*1967;53:721–45.

35. Alikhani M, Chou MY, Khoo E, et al. Age-dependent biologic response to orthodontic forces. *Am J Orthod Dentofacial Orthop.*2018;153:632–44.

36. Nickel JC, Liu H, Marx DB, Iwasaki LR. Effects of mechanical stress and growth on the velocity of tooth movement. *Am J Orthod Dentofacial Orthop.* 2014;145:74-81.

37. Geron S, Shpack N, Kandos S, Davidovitch M, Vardimon AD. Anchorage Loss—A Multifactorial Response. *The Angle Orthodontist.* 2003;73:730–7.

38. Quinn RS, Yoshikawa DK. A reassessment of force magnitude in orthodontics. *Am J Orthod Dentofacial Orthop.*1985;88:252–60.

39. Heo W, Nahm D-S, Baek S-H. En masse retraction and two-step retraction of maxillary anterior teeth in adult Class I women. A comparison of anchorage loss. *Angle Orthod.* 2007;77:973–8.

40. Upadhyay M, Yadav S, Nagaraj K, Patil S. Treatment effects of mini-implants for en-masse retraction of anterior teeth in bialveolar dental protrusion patients: a randomized controlled trial. *Am J Orthod Dentofacial Orthop.*2008;134:18-29.e1.

4 CONCLUSÕES

Baseado nos resultados e conclusões apresentados nos capítulos anteriores, chegamos as seguintes considerações:

- As alterações na retração dos incisivos e nos tecidos moles depois do tratamento são favoráveis para ambos os protocolos de fechamentos de espaços, retração em massa (RM) e retração em duas etapas (RDE). Porém, as mudanças são semelhantes entre as duas técnicas de retração.

- A RM fecha os espaços mais rapidamente do que a RDE. A RDE irá requerer entre 1,8 e 2,2 vezes mais tempo para fechar os espaços das extrações do que a RM. O tempo de RDE é significativamente mais longo para homens do que para mulheres.

- O 1º mês de retração é o período de maiores taxas de movimentação para os caninos e molares durante a primeira etapa de fechamentos dos espaços utilizando a RDE. Após esse período, as taxas de movimentação mensais são constantes até o 7º mês de retração. Além disso, os caninos distalizam e inclinam, com as cúspides se movendo mais que os ápices, enquanto os molares se movem de corpo durante os fechamentos dos espaços.

ACKNOWLEDGEMENTS

We thank for all the support provided from São Paulo Research Foundation (FAPESP), process nº 2015/10099-0, School of Dentistry at Araraquara (UNESP), Brazil and Center for Advanced Dental Education (CADE) at Saint Louis University, USA.

REFERÊNCIAS[*]

1. Bills DA, Handelman CS, BeGole EA. Bimaxillary dentoalveolar protrusion: traits and orthodontic correction. Angle Orthod. 2005;75(3):333–9.

2. Farrow AL, Zarrinnia K, Azizi K. Bimaxillary protrusion in black Americans--an esthetic evaluation and the treatment considerations. Am J Orthod Dentofacial Orthop. 1993;104(3):240–50.

3. Leonardi R, Annunziata A, Licciardello V, Barbato E. Soft tissue changes following the extraction of premolars in nongrowing patients with bimaxillary protrusion. A systematic review. Angle Orthod. 2010;80(1):211–6.

4. Almutairi TK, Albarakati SF, Aldrees AM. Influence of bimaxillary protrusion on the perception of smile esthetics. Saudi Med J. 2015;36(1):87–93.

5. Scott SH, Johnston LE. The perceived impact of extraction and nonextraction treatments on matched samples of African American patients. Am J Orthod Dentofacial Orthop. 1999;116(3):352–60.

6. Solem RC, Marasco R, Guiterrez-Pulido L, Nielsen I, Kim S-H, Nelson G. Three-dimensional soft-tissue and hard-tissue changes in the treatment of bimaxillary protrusion. Am J Orthod Dentofacial Orthop. 2013;144(2):218–28.

7. Kusnoto J, Kusnoto H. The effect of anterior tooth retraction on lip position of orthodontically treated adult Indonesians. Am J Orthod Dentofacial Orthop. 2001;120(3):304–7.

8. Drobocky OB, Smith RJ. Changes in facial profile during orthodontic treatment with extraction of four first premolars. Am J Orthod Dentofacial Orthop. 1989;95(3):220–30.

9. Upadhyay M, Yadav S, Nagaraj K, Patil S. Treatment effects of mini-implants for en-masse retraction of anterior teeth in bialveolar dental protrusion patients: a randomized controlled trial. Am J Orthod Dentofacial Orthop. 2008;134(1):18-29.

10. Konstantonis D, Vasileiou D, Papageorgiou SN, Eliades T. Soft tissue changes following extraction vs. nonextraction orthodontic fixed appliance treatment: a systematic review and meta-analysis. Eur J Oral Sci. 2018;126(3):167–79.

11. Ribeiro GLU, Jacob HB. Understanding the basis of space closure in Orthodontics for a more efficient orthodontic treatment. Dental Press J Orthod. 2016;21(2):115–25.

12. Felemban NH, Al-Sulaimani FF, Murshid ZA, Hassan AH. En masse retraction versus two-step retraction of anterior teeth in extraction treatment of bimaxillary protrusion. J Orthod Sci. 2013;2(1):28–37.

[*] De acordo com o Guia de Trabalhos Acadêmicos da FOAr, adaptado das Normas Vancouver. Disponível no site da Biblioteca: http://www.foar.unesp.br/Home/Biblioteca/guia-de-normalizacao-atualizado.pdf

13. Proffit W, Fields H. The second stage of comprehensive treatment: correction of molar relationship and space closure. In: Proffit W, Fields H. Contemporary orthodontics. St Louis, Mo: CV Mosby; 2000. p. 552–75.

14. Kuhlberg AJ. Steps in orthodontic treatment. In: Kuhlberg AJ. Textbook of orthodontics. Philadelphia: WB Saunders; 2001. p. 240–2.

15. Bennett JC, McLaughlin RP. Controlled space closure with a preadjusted appliance system. J Clin Orthod. 1990;24(4):251–60.

16. Heo W, Nahm DS, Baek SH. En masse retraction and two-step retraction of maxillary anterior teeth in adult Class I women. A comparison of anchorage loss. Angle Orthod. 2007;77(6):973–8.

17. Hixon EH, Atikian H, Callow GE, McDonald HW, Tacy RJ. Optimal force, differential force, and anchorage. Am J Orthod Dentofacial Orthop. 1969;55(5):437–57.

18. Hart A, Taft L, Greenberg SN. The effectiveness of differential moments in establishing and maintaining anchorage. Am J Orthod Dentofacial Orthop. 1992;102(5):434–42.

19. Kulshrestha RS, Tandon R, Chandra P. Canine retraction: a systematic review of different methods used. J Orthod Sci. 2015;4(1):1–8.

20. Burstone CJ. The segmented arch approach to space closure. Am J Orthod Dentofacial Orthop.1982;82(5):361–78.

21. Liu YH, Ding WH, Liu J, Li Q. Comparison of the differences in cephalometric parameters after active orthodontic treatment applying mini-screw implants or transpalatal arches in adult patients with bialveolar dental protrusion. J Oral Rehabil. 2009;36(9):687–95.

22. Nanda R, Kuhlberg A, Uribe F. Biomechanic basis of extraction space closure. In: Nanda R. Biomechanics and sthetic strategies in clinical orthodontics. Saint Louis, Mo: Elsevier Saunders; 1997. p. 194–210.

23. Mavreas D, Athanasiou AE. Factors affecting the duration of orthodontic treatment: a systematic review. Eur J Orthod. 2008;30(4):386–95.

24. Skidmore KJ, Brook KJ, Thomson WM, Harding WJ. Factors influencing treatment time in orthodontic patients. Am J Orthod Dentofacial Orthop. 2006;129(2):230–8.

25. Fisher MA, Wenger RM, Hans MG. Pretreatment characteristics associated with orthodontic treatment duration. Am J Orthod Dentofacial Orthop. 2010;137(2):178–86.

26. Vig PS, Weintraub JA, Brown C, Kowalski CJ. The duration of orthodontic treatment with and without extractions: a pilot study of five selected practices. Am J Orthod Dentofacial Orthop. 1990;97(1):45–51.

27. Fink DF, Smith RJ. The duration of orthodontic treatment. Am J Orthod Dentofacial Orthop. 1992;102(1):45–51.

28. Janson G, Maria FRT, Barros SEC, Freitas MR de, Henriques JFC. Orthodontic treatment time in 2- and 4-premolar-extraction protocols. Am J Orthod Dentofacial Orthop. 2006;129(5):666–71.

29. Beckwith FR, Ackerman RJ, Cobb CM, Tira DE. An evaluation of factors affecting duration of orthodontic treatment. Am J Orthod Dentofacial Orthop. 1999;115(4):439–47.

30. Xu TM, Zhang X, Oh HS, Boyd RL, Korn EL, Baumrind S. Randomized clinical trial comparing control of maxillary anchorage with 2 retraction techniques. Am J Orthod Dentofac Orthop. 2010;138:544.e1–e9.

31. Pilon JJGM, Kuijpers-Jagtman AM, Maltha JC. Magnitude of orthodontic forces and rate of bodily tooth movement. An experimental study. Am J Orthod Dentofacial Orthop.1996;110(1):16–23.

32. van Leeuwen EJ, Maltha JC, Kuijpers-Jagtman AM. Tooth movement with light continuous and discontinuous forces in beagle dogs. Eur J Oral Sci. 1999;107(6):468–74.

33. Thiruvenkatachari B, Ammayappan P, Kandaswamy R. Comparison of rate of canine retraction with conventional molar anchorage and titanium implant anchorage. Am J Orthod Dentofacial Orthop. 2008;134(1):30–5.

34. Shpack N, Davidovitch M, Sarne O, Panayi N, Vardimon AD. Duration and anchorage management of canine retraction with bodily versus tipping mechanics. Angle Orthod. 2008;78(1):95–100.

35. Hayashi K, Uechi J, Murata M, Mizoguchi I. Comparison of maxillary canine retraction with sliding mechanics and a retraction spring: a three-dimensional analysis based on a midpalatal orthodontic implant. Eur J Orthod. 2004;26(6):585–9.

36. Nightingale C, Jones SP. A clinical investigation of force delivery systems for orthodontic space closure. J Orthod. 2003;30(3):229–36.

37. Herman RJ, Currier GF, Miyake A. Mini-implant anchorage for maxillary canine retraction: a pilot study. Am J Orthod Dentofacial Orthop. 2006;130(2):228–35.

38. Bokas J, Woods M. A clinical comparison between nickel titanium springs and elastomeric chains. Aust Orthod J. 2006;22(1):39–46.

39. Oz AA, Arici N, Arici S. The clinical and laboratory effects of bracket type during canine distalization with sliding mechanics. Angle Orthod. 2012;82(2):326–32.

40. Dixon V, Read MJF, O'Brien KD, Worthington HV, Mandall NA. A randomized clinical trial to compare three methods of orthodontic space closure. J Orthod. 2002;29(1):31–6.

41. da Costa Monini A, Júnior LGG, Martins RP, Vianna AP. Canine retraction and anchorage loss: self-ligating versus conventional brackets in a randomized split-mouth study. Angle Orthod*.* 2014;84(5):846–52.

ANEXO A – CERTIFICADO DO COMITÊ DE ÉTICA

UNIVERSIDADE ESTADUAL PAULISTA "JÚLIO DE MESQUITA FILHO"

FACULDADE DE ODONTOLOGIA DE ARARAQUARA

Comitê de Ética em Pesquisa em Seres Humanos

Certificado

Certificamos que o relatório final do projeto de pesquisa intitulado *"AVALIAÇÃO DO TEMPO DE TRATAMENTO E PERDA DE ANCORAGEM ENTRE DUAS FORMAS DE RETRAÇÃO ANTERIOR"*, sob o protocolo nº **1/09**, de responsabilidade do Pesquisador *LUIZ GONZAGA GANDINI JÚNIOR*, está de acordo com a Resolução 466/12 do Conselho Nacional de Saúde/MS, de 12/12/2012, publicada no DOU de 13/06/2013, tendo sido aprovado pelo Comitê de Ética em Pesquisa–FOAr-UNESP.

This is to certify that the final technical report of the research project entitled *"EVALUATION OF THE TREATMENT AND LOSS OF ANCHORAGE IN TWO METHODS OF ANTERIOR RETRACTION"* protocol number **1/09**, under *LUIZ GONZAGA GANDINI JÚNIOR's* responsibility, is according with the Resolution 466/12 of National Health Council/Ministry of Health of December 12th of 2012, published on DOU in June 13th of 2013. This research has been approved by Research Ethic Committee, FOAr-UNESP.

Araraquara, 16 de Setembro de 2014.

MMSNagle

Prof. Dr. Maurício Meirelles Nagle
Coordenador

ANEXO B - CERTIFICADO DE COMITÊ DE ÉTICA

UNESP - FACULDADE DE ODONTOLOGIA - CAMPUS ARARAQUARA

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Avaliação do padrão de movimentação de molares, caninos, incisivos e mudanças labiais em casos de extração de pré-molares em pacientes Classe I de Angle, biprotrusos.

Pesquisador: Luiz Gonzaga Gandini Junior

Área Temática:

Versão: 4

CAAE: 65053917.2.0000.5416

Instituição Proponente: Faculdade de Odontologia de Araraquara - UNESP

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 2.025.357

Apresentação do Projeto:

O projeto é relevante, como mostra a introdução muito bem redigida, é exequível dentro de um cronograma adequado e está dentro das normas do Comitê de Ética da FOAr/UNESP. Trata-se de um estudo retrospectivo em que serão coletados dados de telerradiografias cefalométricas em norma lateral e oblíqua de 45° e de modelos de estudos obtidos durante o tratamento ortodôntico que envolveu a extração de quatro primeiros pré-molares, de 48 pacientes com má oclusão Classe I de Angle, biprotrusos, cujo tratamento ortodôntico corretivo com fechamento dos espaços foi realizado em uma única etapa (G1) ou em duas etapas (G2). As medidas lineares obtidas serão submetidas a análise estatística apropriada.

Objetivo da Pesquisa:

Avaliar as mudanças labiais e o padrão de movimentação de molares, caninos e incisivos em pacientes adultos, classe I de Angle, com biprotusão, tratados seguindo dois protocolos de fechamento de espaço após a extração pré-molares.

Avaliação dos Riscos e Benefícios:

Riscos: Considerando que serão utilizados modelos de estudos e telerradiografias laterais e oblíquas de 45°, direita e esquerda, pertencentes ao arquivo de documentação ortodôntica do

Endereço: HUMAITA 1680
Bairro: CENTRO **CEP:** 14.801-903
UF: SP **Município:** ARARAQUARA
Telefone: (16)3301-6459 **E-mail:** cep@foar.unesp.br

Programa de Pós-graduação em Ciências Odontológicas, área de Ortodontia, da Faculdade de Odontologia de Araraquara, a pesquisa apresentará risco mínimo uma vez que serão mantidos em sigilo a identidade dos pacientes e os dados confidenciais envolvidos na pesquisa. Todos os adultos foram tratados e os tratamentos promoveram correção da biprotrusão, devolvendo equilíbrio facial com a harmonização dos dentes, lábios e ossos maxilares.

Benefícios: Neste trabalho espera-se verificar se existem diferenças entre as duas técnicas de retração, em uma etapa e duas etapas, no que se refere a movimentação de molares, caninos, incisivos e mudanças labiais; afim de otimizar o trabalho do ortodontista e possibilitar a seleção da técnica que promova mudanças mais favoráveis e em menor tempo ao arco dentário. Todas os adultos tiveram a Biprotusão corrigidas, reestabelecendo o equilíbrio facial e dentário.

Comentários e Considerações sobre a Pesquisa:

Projeto bem apresentado, respeitando as normas do CEP.

Considerações sobre os Termos de apresentação obrigatória:

Os seguintes documentos foram apresentados e estão adequados:

- Declaração do pesquisador
- Autorização para uso de arquivos
- Declaração de não ressarcimento de gastos
- Autorização para uso da infraestrutura
- Orçamento financeiro
- Cronograma da pesquisa
- Solicitação de dispensa do TCLE

Conclusões ou Pendências e Lista de Inadequações:

Não existem pendências.

Considerações Finais a critério do CEP:

Protocolo APROVADO em reunião de 20 de Abril de 2017.

O pesquisador deverá encaminhar relatórios parciais a cada 01 (um) ano até o prazo final da pesquisa, quando deverá encaminhar o relatório final.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação

UNESP - FACULDADE DE ODONTOLOGIA - CAMPUS ARARAQUARA

Continuação do Parecer: 2.025.357

Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_866648.pdf	15/03/2017 23:27:28		Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_com_reconsideracoes.pdf	10/03/2017 15:28:04	Patricia Pigato Schneider	Aceito
Declaração de Pesquisadores	declaracao_pesquisdor.pdf	21/02/2017 11:18:50	Luiz Gonzaga Gandini Junior	Aceito
Outros	autorizacao_uso_documentacao.pdf	21/02/2017 11:17:03	Luiz Gonzaga Gandini Junior	Aceito
Outros	declaracao_ressarcimento_gastos.pdf	21/02/2017 11:15:22	Luiz Gonzaga Gandini Junior	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_detalhado.pdf	21/02/2017 11:13:53	Luiz Gonzaga Gandini Junior	Aceito
Declaração de Instituição e Infraestrutura	declaracao_instituicao.pdf	21/02/2017 11:10:39	Luiz Gonzaga Gandini Junior	Aceito
Orçamento	orcamento_financeiro.pdf	21/02/2017 11:10:06	Luiz Gonzaga Gandini Junior	Aceito
Cronograma	cronograma_de_trabalho.pdf	21/02/2017 11:08:23	Luiz Gonzaga Gandini Junior	Aceito
Folha de Rosto	Folha_de_rosto.pdf	21/02/2017 11:07:52	Luiz Gonzaga Gandini Junior	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

ARARAQUARA, 20 de Abril de 2017

Assinado por:
Andréa Gonçalves
(Coordenador)