UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ODONTOLOGIA DE BAURU

PAULA PATRÍCIA COTRIN DA SILVA

Long-term comparison of occlusal relapse in cases treated with and without premolar extraction

Comparação da recidiva oclusal em longo-prazo em casos tratados com e sem extração de pré-molares

BAURU
2020

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Tese constituída por artigos apresentada à Faculdade de Odontologia de Bauru da Universidade de São Paulo para obtenção do título de Doutor em Ciências no Programa de Ciências Odontológicas Aplicadas, na área de concentração Ortodontia.

Orientador: Prof. Dr. Marcos Roberto de Freitas

BAURU

2020

Silva, Paula Patrícia Cotrin da
Long-term comparison of occlusal relapse in cases treated with and without premolar extraction -- Bauru, 2020.
133 p. : il. ; 31 cm.

Tese (Doutorado) -- Faculdade de Odontologia de Bauru, Universidade de São Paulo, 2020.

Orientador: Prof. Dr. Marcos Roberto de Freitas

.

Comitê de Ética da FOB-USP
Protocolo nº: 71629217.5.0000.5417
Data: 12/02/2020

ERRATA

FOLHA DE APROVAÇÃO

DEDICATÓRIA

Um pequeno passo para a humanidade, mas uma enorme maratona para mim, em todos os sentidos. Essa é a realização de um sonho, uma vitória pessoal. E como “todas as vitórias ocultam uma renúncia” (Simone de Beauvior), em nome de todas as renúncias que fiz por ela, dedico este trabalho:

A primeira pessoa que dedico este trabalho não poderia deixar de ser minha querida mãe **Erceli Cotrin**, que se não bastasse ser o melhor ser humano que conheço, ainda foi permitido que fosse minha mãe nessa jornada. Ela que sempre lutou para que eu realizasse todos os meus sonhos, mesmo que muitas vezes isso significasse abrir mão dos dela. Tudo o que eu sou foi porque você me amou. Esta vitória é nossa! Muito obrigada por tudo!

À minha irmã **Tassia Cotrin,** minha maior incentivadora e defensora dessa vida. Ter você ao meu lado pra contar a nossa história é um grande presente!

Ao meu irmão **Victor Cotrin** e a à minha cunhada **Rafaela Gomes** pelo incentivo nos momentos difíceis.

À **Ana Paula Pulsides**, que acompanhou todo o processo deste doutorado, desde a semente das ideias até a conclusão do mesmo, por vezes me incentivando, por vezes me puxando pra realidade, mas sempre ao meu lado. Mil vezes obrigada!

Às minhas sobrinhas **Maria Victória e Carolina** por serem a forma de amor mais puro em nossas vidas.

AGRADECIMENTOS

Obrigada **Deus**... “Talvez não tenha conseguido fazer o melhor, mas lutei para que o melhor fosse feito. Não sou o que deveria ser, mas Graças a Deus, não sou o que era antes”. (Marthin Luther King)

À minha amada mãezinha **Erceli**, minha professora da escola e da vida, obrigada pelo incentivo, pelo apoio, torcida, por ouvir minhas reclamações, por estar sempre ao meu lado, me amando, não deixando que eu desistisse, enxugando minhas lágrimas, sempre perguntando as coisas mesmo sem entender nada, tentando me consolar nos períodos de maior desânimo. Obrigada pelas orações, pelos anjos mandados na estrada... Nem que eu viva mil vidas jamais poderei expressar toda a gratidão que tenho por você!

À minha querida irmã **Tássia,** que também segurou em minhas mãos todos esses anos, me incentivando e apoiando. Ter você como fã é uma grande responsabilidade. Me faz querer ser melhor todos os dias.

Ao meu irmão **Victor**, minha cunhada **Rafaela** e sobrinhas **Maria e Carol** que sempre foram entusiastas das minhas jornadas, muito obrigada.

À **Ana Paula** que ouviu até a exaustão todos os meus medos, desde a preparação para a prova do doutorado até a conclusão deste trabalho. Pacientemente (muitas vezes nem tanto - risos) ouviu todas as minhas reclamações e a partir delas, me aconselhou e apoiou. Me fez enxergar com clareza quando tudo parecia sem solução. Me fez enxergar a razão das coisas quanto tudo parecia inexplicável. Quebrou inúmeros galhos. Me fez rir dos problemas. Obrigada pela presença, pelo apoio e companheirismo. Eu não teria conseguido sem você!

À professora e orientadora **Dra. Karina Freitas**, parte fundamental deste trabalho. Minha eterna gratidão por todos estes anos de valiosos ensinamentos, desde o mestrado até agora. Muito obrigada por todas as oportunidades, por toda a paciência, por despertar em mim o amor pela ciência, por acreditar e, principalmente, por não desistir de mim! Saiba que é meu grande exemplo!!!

Aos meus afilhados **Gustavo e Surya**, obrigada por existirem em minha vida, obrigada pelo amor incondicional e me desculpem pela ausência por todos esses anos...

À Dra. **Marli Albuquerque** (*in memorian*), um grande exemplo de profissional e ser humano, que mesmo sem saber, acabou me colocando nesta grande estrada que é a Ortodontia.

Ao meu querido professor da especialização e um dos melhores ortodontistas que eu conheço: Professor Ms. **Cesar Nelclair Fassa Garcia**. O primeiro a acreditar em mim e a me fazer entender que a Ortodontia é linda e que é possível deixar de ser "dente de leite" estudando. Você foi muito importante pra minha história. Obrigada por todos os ensinamentos, dicas e tempo compartilhados comigo!

Às minhas colaboradoras do consultório **Ariana Aparício e Simone Rissato**, que cuidaram tão bem dos meus pacientes e do meu consultório durante minhas ausências. Obrigada por pacientemente arrumar e desarrumar minha mala de materiais todos os meses. Obrigada por não enlouquecerem com a minha agenda. Muito Obrigada!

Aos meus sócios **Dr. Renato Albuquerque e Dr. Renato Albuquerque Filho**, obrigada pelo acolhimento e apoio.

Às minhas colaborados do posto de saúde, em especial a **Anne Bolson**, minha grande cúmplice, que também me ajudou muito quebrando todos os galhos possíveis e impossíveis!

Às minhas amigas **Elizabete e Jô,** obrigada pelo apoio e incentivo, companheirismo e torcida! Espero que agora a gente possa realmente por o nome do nosso grupo em prática!

Às minhas **amigas da Patota**, reencontrá-las ano passado foi combustível essencial para minha vida. Ter uma história linda com vocês me faz uma pessoa melhor!

Aos meus **colegas do Mestrado da Uningá** obrigada pelos 2 anos de delicioso convívio, das risadas e histórias compartilhadas, além de conhecermos juntos os caminhos da ciência. Gostaria de agradecer em especial 2 amigas: **Fabiana Pazian**, que foi a maior entusiasta deste meu doutorado, que em momento nenhum deixou que eu desistisse da ideia e vibrou com todas as minhas conquistas. Esse ano ela será presenteada com o Matheus, que abençoará ainda mais a linda família que ela formou! Também gostaria de agradecer a **Adriana Oliveira**, que ouviu meus primeiros desabados sobre o doutorado, e que nunca duvidou que eu conseguiria. Obrigada pelo apoio meninas!

Aos meus **gatos e cachorros** que me deram a mais pura prova de amor incondicional durante a realização deste trabalho, seja ficando silenciosamente ao meu lado (cachorros) ou passeando despretensiosamente em cima do meu notebook (gatos). Em especial aos bichinhos que nos deixaram durante este período: Berlin, Theo, Pandora, Chico e Pablo.

Agradeço especialmente ao meu estimado orientador professor **Dr. Marcos Roberto de Freitas**, que tão bem me acolheu nesta casa. Obrigada pela atenção e disponibilidade durante a realização deste trabalho. Obrigada pelo sorriso leve e constante durante toda a nossa jornada. Obrigada por compartilhar seus ensinamentos. Não tenho palavras para agradecer a imensa oportunidade que tive em aprender e conviver com este que é um grande pilar da ortodontia brasileira. Muito obrigada!

Agradeço também ao **"Prezado professor Dr. Guilherme Janson"**, por todo o aprendizado dedicado à nossa turma, e a todo o departamento de Ortodontia. Agradeço a oportunidade de aprender com este que tem a ciência, a organização e a disciplina como lema de vida. Doutor Guilherme tem o toque de midas. Tudo o que ele toca vira ouro. Aprendizado para a vida. Muito obrigada!

Agradeço aos meus professores do Mestrado da Uninga: **Dr. Fabrício Pinelli Valarelli e Dr. Rodrigo Hermont Cançado**. Muito obrigada pela honra da presença e por todas as oportunidades a mim dispensadas. Se hoje consigo ver mais longe foi porque me apoiei nos ombros de gigantes!

Agradeço com todo o meu coração os amigos do então **Mestrado 2017**, que depois viraram “Doutorado Novo 2019”: Cinthya Quagliato, Danelin Reyes, Gabriela Natsumeda, Jessica Almeida, Maria Cláudia, Olga Maranhão, Rodrigo Naveda, José Pelayo, Silvio Beline, Maria Pia, Marcelo Valério e Cristina Bastiani por também terem me recebido tão bem na minha entrada na USP. Conviver com vocês foi um privilégio. Vocês tornaram meu doutorado mais leve e prazeroso. Aprendi muito com vocês. Sentirei muitas saudades, mas sei que nos encontraremos muito por aí, e também sei que cada seguirá um caminho pleno de sucesso!!!! Também não posso deixar de agradecer aos novos amigos do **Mestrado 2019**: Demi, Jéssica, Thagid, Gonzalo, Ronald, Vinícius, Thales e Henrique pela prontidão em sempre ajudar os “seniores”, pelo riso da juventude e também pela agradável presença. Não poderia deixar de agradecer também ao **Bruno Vieira,** colega do “doutorado velho” que sempre foi muito prestativo em tudo o que precisamos. E também aos “new fobianos” do **doutorado novo**: Graziane, Luciana e Marcelo.

E, com um misto de quentinho no coração, tristeza e saudade agradeço a minha turma incrível de doutorado: **Aron Aliaga, Camila Massaro, Deborah Brindeiro, Fabiola Alvarez, Felicia Miranda, Lorena Vilanova, Ludmila Mangialardo e Raquel Poleto**. Foram 3 intensos anos ao lado de vocês. Obrigada pela acolhida e por todo o aprendizado! “E pela lei natural dos encontros, eu deixo e recebo ou tanto...” Cada um ficará marcado na minha vida para sempre. E, ao falar desta turma incrível, não poderia deixar de agradecer em especial 2 pessoas: Minha “dupla”, parceira de pesquisa **Caroline Gambardela (Quérol) e Wilana Moura (Wiwi).** Essas duas são minhas nerdzinhas favoritas. Quérol é extremamente organizada, praticamente uma Sherlock Holmes da ortodontia. Ela foi a responsável pela busca e chamamento da maioria dos pacientes da nossa amostra, assim como pela organização digital da mesma, além, claro, de se preocupar com a minha maquiagem no dia da defesa! Muito obrigada! Wiwi é a deusa do impossível. Seu lema é: não sabendo que era impossível, foi lá e fez! Sempre disposta a ajudar, resolutiva e ágil! Elas estiveram ao meu lado em todos estes anos, me ajudando, me animando, me suportando. Menção honrosa pra Wiwi, que, na reta final, mesmo ocupadíssima, pacientemente me ajudou com todas as dúvidas existentes!!!! Obrigada, meninas! Vocês tornaram meus dias em Bauru mais doces e melhores!

Agradeço aos professores do departamento de Ortodontia da FOB: **Dr. Arnaldo Pinzan, Dra. Daniela Garib, Dr. José Fernando Castanha Henriques e Dr. Renato Almeida**. Obrigada pelos ensinamentos e pela oportunidade de partilhar um período da minha vida com a história viva da ortodontia mundial e brasileira.

Aos alunos de **especialização da FOB e da Funbeo** pela oportunidade do aprendizado durante as monitorias de clínica e laboratórios.

Agradeço também aos funcionários do departamento de Ortodontia: **Wagner, Lourisvalda, Vera e Cleo**. Um agradecimento especial à Verinha e Cleo que sempre, pacientemente, me ensinaram como proceder tanto em eventos burocráticos como em procedimentos na clínica.

Ao **Daniel (Bonné)** pela prontidão em ajudar com os computadores. Sua ajuda foi essencial.

Às funcionárias da **secretaria de pós-graduação**: Fátima (*in memorian),* Leila e Letícia pela excelente ajuda com a parte burocrática deste doutorado.

Aos **funcionários da esterilização**, que sempre me atenderam muito bem durante o período de atendimento em clínicas.

A todos os **funcionários da FOB** de maneira geral, muito obrigada.

Agradeço também ao Dr. **Bruno Frazão Gribbel** e a Compass pela prontidão em ajudar com a versão trial do software OrthoAnalyzer. Sua ajuda foi preciosa!

À protética **Karla Patrícia Carvalho** e sua ajuda incrível na confecção dos modelos de gesso.

Agradeço também especialmente, em meu nome e da minha "dupla" Caroline a colaboração da Giovanna e Samuel, e também todos os funcionários da **Clínica Radiológica 3D**, por nos ajudarem com o atendimento dos nossos pacientes.

Agradeço a **D. Neusa** que nos acolheu em sua casa durante o primeiro ano de doutorado, e também aos funcionários do **City Hotel**, nossa segunda casa durante os anos restante de estudo. Obrigada pela gentileza e por todos os late check-outs concedidos!!!!

À **Faculdade de Odontologia de Bauru**, Universidade de São Paulo, na pessoa do diretor Prof. Dr. Carlos Ferreira dos Santos; e do vice-diretor Prof. Dr. Guilherme dos Reis Pereira Janson e a **todos os seus funcionários**.

À **CAPES** pelo apoio financeiro e pelo incentivo ao desenvolvimento de pesquisa e ciência no Brasil. O presente trabalho foi realizado com o apoio da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Código de Financiamento 001.

A todos que colaboraram de forma direta ou indireta na realização e finalização desse trabalho e que, porventura, não foram mencionados

E, por último, agradeço à parte fundamental deste trabalho: **todos os pacientes que se voluntariaram a participar da nossa pesquisa**. Foi muito bom poder recordar junto deles os momentos vividos nesta instituição. A todos vocês, a minha mais profunda gratidão!

“Nobody said it was easy
It's such a shame for us to part
Nobody said it was easy
No one ever said it would be this hard
Oh take me back to the start”.

The Scientist, Coldplay

ABSTRACT

Long-term comparison of occlusal relapse in cases treated with and without premolar extraction

Objective: The aim of this study was to compare the occlusal relapse in nonextraction and extraction orthodontic treatments in the long-term. **Material and methods:** The sample comprised 57 Class I and Class II malocclusion patients were divided into 2 groups: Group 1: 16 patients treated nonextraction, with mean initial, final and long-term posttreatment ages of 13.20, 15.07 and 50.32 years, respectively. Mean treatment and long-term follow-up times were 1.86 and 35.25 years. Group 2: 41 patients treated with 4-premolars extraction, with mean initial, final and long-term posttreatment ages of 13.31, 15.63 and 53.60 years, respectively. Mean treatment and long-term follow-up times were 2.32 and 37.96 years. Dental casts were obtained and digitized at pretreatment (T1), posttreatment (T2) and long-term posttreatment (T3) stages. The following measurements were obtained: Little irregularity Index, arch length and perimeter, intercanine, interpremolar and intermolar widths, PAR and OGS indexes. The subjects also answered an on-line questionnaire on the esthetic and occlusal self-perception at T3. Intergroup comparison was performed with independent t tests. **Results:** At the long-term, all arch dimensions, except intercanine width, were significantly smaller in the extraction group. Both groups showed similar amount of relapse and arch dimension changes in the long-term, except for the mandibular arch perimeter. The percentage of mandibular anterior crowding relapse was significantly greater in nonextraction (84.46%) than in extraction group (44.66%). PAR index improved with treatment and relapsed at the long-term in both groups. Nonextraction group showed greater relapse according to OGS index than extraction cases. Nonextraction patients perceived more changes in alignment over time than extraction individuals, but overall satisfaction was similar. **Conclusions:** There was no difference in the amount of long-term relapse of anterior crowding and transversal arch dimensions in cases treated with and without extraction. The percentage of relapse of mandibular anterior crowding was significantly higher in the nonextraction than in the extraction group. Mandibular arch perimeter showed more decrease in the long-term in extraction cases. The nonextraction group showed more occlusal relapse and perceived more changes in alignment over time, but overall patient satisfaction was similar for both groups.

Keywords: Malocclusion. Relapse. Stability. Tooth extraction.

RESUMO

Comparação da recidiva oclusal em longo-prazo em casos tratados com e sem extração de pré-molares

Objetivo: O objetivo deste trabalho foi comparar a recidiva oclusal em longo prazo em casos ortodônticos tratados com e sem extrações dentárias. **Material e métodos**: A amostra foi constituída por 57 pacientes com má oclusão de Classe I e II, divididos em 2 grupos: Grupo 1: 16 pacientes tratados sem extração, com média de idade inicial, final e longo prazo de 13,20, 15,07 e 50,32 anos, respectivamente. Os tempos médios de tratamento e avaliação em longo prazo foram 1,86 e 35,25 anos. Grupo 2: 41 pacientes tratados com extrações de pré-molares, com média de idade inicial, final e longo prazo pós-tratamento de 13,31, 15,63 e 53,60 anos, respectivamente. Os tempos médios de tratamento e avaliação em longo prazo foram 2,32 e 39,96 anos. Os modelos de gesso iniciais (T1), finais (T2) e longo prazo pós-tratamento (T3) foram obtidos e digitalizados. As seguintes medidas foram obtidas: Índice de Irregularidade de Little, comprimento e perímetro do arco, distâncias intercaninos, interpré-molares e intermolares, índices PAR e OGS. Os pacientes também responderam a um questionário on-line sobre sua autopercepção estética e oclusal no longo prazo pós-tratamento. A comparação intergrupos foi realizada pelo teste t independente. **Resultados**: Em longo prazo, todas as dimensões dos arcos, exceto a distância intercaninos, foram significativamente menores no grupo com extração. Ambos os grupos apresentaram quantidade semelhante de recidiva e alterações na dimensão dos arcos em longo prazo, exceto no perímetro do arco inferior. A porcentagem de recidiva do apinhamento anteroinferior foi significativamente maior no grupo sem extração (84,46%) do que no grupo com extração (44,66%). O índice PAR melhorou com o tratamento e recidivou em longo prazo em ambos os grupos. O grupo sem extração apresentou maior recidiva de acordo com o índice OGS do que os casos com extração. Pacientes sem extração perceberam mais alterações no alinhamento ao longo do tempo do que indivíduos com extração, mas a satisfação em geral foi semelhante. **Conclusões**: Não houve diferença na quantidade de recidiva em longo prazo do apinhamento anterior e nas dimensões transversais dos arcos nos casos tratados com e sem extração. A porcentagem de recidiva do apinhamento anteroinferior foi significativamente maior no grupo sem extração do que no grupo com extração. O perímetro do arco inferior apresentou maior diminuição a longo prazo nos casos de extração. O grupo sem extração mostrou mais recidiva oclusal e percebeu mais alterações no alinhamento ao longo do tempo, mas a satisfação geral do paciente foi semelhante nos dois grupos.

Palavras-chave: Má oclusão. Recidiva. Estabilidade. Extrações dentárias.

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LIST OF ABREVIATIONS AND ACRONYMS

T1	Pretreatment
T2	Posttreatment
T3	Long-term posttreatment follow-up
T2 – T1	Treatment changes
T3 – T2	Relapse
Mx	Maxilla
Md	Mandible
SD	Standard deviation
3-3 width	Intercanine width
5-5 width	Interpremolar width
6-6 width	Intermolar width
PAR	Peer Assessment Rating
OGS	Objective Grading System
C-R	Cast and radiograph

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1 INTRODUCTION

1 INTRODUCTION

If dental professionals were asked about their orthodontic treatment goals, they might mention pleasant smiles, good occlusal function and mainly stability of the results obtained over the years. Long-term stability of orthodontic treatment has been extensively studied and difficult to predict.(Dyer; Vaden; Harris, 2012; Freitas et al., 2017; Little, 1999) Besides that, it is known that dental occlusion is dynamic. Changes will occur regardless of the technique, appliance and treatment protocol used. These changes can be desired by the orthodontist, called “settling of the occlusion”(Dincer; Meral; Tumer, 2003) or not, causing great discomfort for the clinician and the patient, the much-feared “relapse”. It is of paramount importance to determine if some trait of the orthodontic treatment might improve or worsen over time.

Relapse of the mandibular anterior segment during the postretention period is perhaps the most predictable and frustrating of all orthodontic relapses.(Shah, 2003) Relapse is defined as the tendency for the teeth to move from the positions in which they were placed by the orthodontics. Some authors, however, prefer to call it physiologic recovery, that is the changes that represent a rebound or reversion toward the original malocclusion.(Horowitz; Hixon, 1969) The long-term response of the anterior alignment is unpredictable; no variables, such as degree of initial crowding, age, sex and Angle classification is useful in establishing a prognosis.(Little, 1990) Typically, arch width and length decrease after retention, regardless of treatment expansion or constriction. Two thirds of the patients have unsatisfactory mandibular anterior alignment after retention.(Erdinc; Nanda; Isiksal, 2006; Freitas et al., 2004; Little; Wallen; Riedel, 1981)

The evaluation of the orthodontic treatment outcomes for a long time was subjective, so in this context, the orthodontists’ experience determined his success or failure. The ideal parameter for orthodontic treatments finishing was based on the six keys to normal occlusion.(Andrews, 1972) The use of objective criteria is essential to uniformly quantify and measure the severity of malocclusions, the efficacy of different treatment modalities as well to assess the relapse of orthodontic treatments.(Chalabi et al., 2015) Attempts have recently been made to evaluate treatments in a more

objective way,(Otuyemi; Jones, 1995b) allowing clinicians worldwide to speak the same language regarding the orthodontic treatment outcomes. In this context, the Peer Assessment Rating (PAR index) and the American Board of Orthodontics Objective Grading System (OGS) are two of the most used indexes to evaluate treatment outcomes and stability.(Casko et al., 1998; DeGuzman et al., 1995; Richmond et al., 1992a; Richmond et al., 1992b)

The PAR Index was developed to measure treatment outcomes in orthodontics(Richmond et al., 1992a; Richmond et al., 1992b) and its validity was improved by weighting the scores of some components to reflect their relative importance.(DeGuzman et al., 1995) More recently, in order to assess the adequacy of finished orthodontic results, The American Board of Orthodontics (ABO) developed a model grading system (Objective Grading System OGS) as an occlusal index to evaluate posttreatment dental casts.(Casko et al., 1998) It assesses the final occlusion of treated cases.

Follow-up studies of treated cases show that although the improvement in the dentition, there is a tendency to return toward the original malocclusion many years posttreatment.(Bondemark et al., 2007; Uhde; Sadowsky; BeGole, 1983) They also report that irregularity increases are slightly greater in patients treated with mandibular premolars extractions and in patients followed up over longer periods of time.(Swidi; Griffin; Buschang, 2019)

Extraction in orthodontics has remained a subject of controversial debates and speculations over time.(Rinchuse et al., 2014) In the early 1900's, Angle believed that if bone could be grown after the teeth were moved off their bony bases, the proper function of the dentition could maintain teeth in their correct positions, reaching long-term stability.(Angle, 1907) However, by the 1930's orthodontists were beginning to notice relapse. Charles H. Tweed, concerned with dental protrusions and unsatisfactory facial esthetics, started to begin extracting 4 premolars in certain patients after initially following Angle´s nonextraction dogma.(Wahl, 2005) His criterion for facial balance was the final position of the mandibular central incisors. Premolar extraction to permit alignment of crowded teeth has been an accepted procedure for decades and continues to be a common treatment modality for patients with crowded arches.(Erdinc; Nanda; Isiksal, 2006) Because of changing concepts of facial soft-

tissue profile esthetics and late growth changes, the trend in orthodontics has been toward nonextraction treatment.(Dardengo Cde; Fernandes; Capelli Junior, 2016; Erdinc; Nanda; Isiksal, 2006) Dardengo et al.(Dardengo Cde; Fernandes; Capelli Junior, 2016) stated that the frequency of tooth extraction over a period of 32 years decreased by approximately 20%. But, teeth extraction for orthodontic purposes are still well indicated in many cases.

There is a lack in the literature regarding what kind of treatment will lead to a major stability and what are the dental arch dimension changes when comparing extraction and nonextraction treatments in the long-term. Most of the follow up studies focused on morphologic changes in the mandibular arch evaluating only patients treated nonextraction(Freitas et al., 2004; Glenn; Sinclair; Alexander, 1987; Sadowsky et al., 1994; Weinberg; Sadowsky, 1996) or with extraction of pre-molars(Dyer; Vaden; Harris, 2012; Freitas et al., 2006; Little; Riedel; Artun, 1988; Little; Riedel; Engst, 1990; Little; Wallen; Riedel, 1981). Besides that, it was extensively previously demonstrated in the orthodontic literature that the great majority of the long-term studies is focused in the functional and esthetic parameters and some kind of deviations from the normal. Recently, researches changed their focus toward the patient perspective of the orthodontic treatment and their correlated satisfaction and quality of life.(Pacheco-Pereira et al., 2015) There is no known study comparing the maxillary and mandibular crowding and dental arch dimensions' relapse, patient satisfaction as well as the relapse evaluated with the PAR index and ABO OGS between extraction and nonextraction treatments more than 35 years postretention.

The objective of this study is to test the null hypothesis that there is no difference regarding crowding and dental arch dimensions relapse, patient satisfaction, as well as to compare the outcomes and the long-term occlusal stability between patients treated with and without extractions using the PAR and OGS indexes after 35 years postretention.

2 ARTICLES

2 ARTICLES

The articles presented in this Thesis were written according to the American Journal of Orthodontics and Dentofacial Orthopedics instructions and guidelines for article submission (Annex B).

- **Article 1 -** Long-term comparison of anterior crowding and dental arch dimensions relapse in cases treated with and without extractions.

- **Article 2 –** Treatment outcomes, long-term comparison of occlusal relapse and patient satisfaction in cases treated with and without extractions.

ARTICLE 1

Long-term comparison of anterior crowding and dental arch dimensions relapse in cases treated with and without extractions

ABSTRACT

Objective: To compare anterior crowding and dental arch dimensions relapse in nonextraction and extraction treatments in the long-term. **Material and Methods**: 57 Class I and Class II malocclusion patients were divided into 2 groups: G1: 16 patients treated nonextraction, with mean initial, final and long-term posttreatment ages of 13.20, 15.07 and 50.32 years, respectively. Mean treatment and long-term follow-up times were 1.86 and 35.25 years, respectively. G2: 41 patients treated with 4-premolars extraction, with mean initial, final and long-term posttreatment ages of 13.31, 15.63 and 53.60 years, respectively. Mean treatment and long-term follow-up times were 2.32 and 37.96 years, respectively. Dental casts were obtained and digitized at pretreatment (T1), posttreatment (T2) and long-term posttreatment (T3). The following measurements were obtained: Little irregularity Index, arch length and perimeter, intercanine, interpremolar and intermolar widths. Intergroup comparison was performed with independent t-tests. **Results:** At the long-term, all arch dimensions, except intercanine width, were significantly smaller in the extraction group. Both groups showed similar amount of relapse and arch dimension changes in the long-term, except for the mandibular arch perimeter. The percentage of mandibular anterior crowding relapse was significantly greater in nonextraction (84.46%) than in extraction group (44.66%). **Conclusion:** There was no difference in the amount of long-term relapse of anterior crowding and transversal arch dimensions in cases treated with and without extraction. The percentage of relapse of mandibular anterior crowding was significantly higher in the nonextraction than in the extraction group. Mandibular arch perimeter showed more decrease in the long-term in extraction cases.

Keywords: Malocclusion; Relapse; Tooth Extraction; Orthodontics; Crowding; Incisor.

INTRODUCTION

Posttreatment stability is one of the most challenging aspects of orthodontic treatment and is a concern to all orthodontists. Moreover, long-term posttreatment stability of anterior tooth alignment is of major interest for both patients and clinicians.[1] Anterior crowding relapse is an unforeseeable phenomenon that inevitably occurs in most treated cases.[2,3] It may be interpreted by the patient as a treatment failure.[4]

The long-term response of the anterior alignment is unpredictable; no variables, such as degree of initial crowding, age, sex and Angle classification is useful in establishing a prognosis.[5] Typically, arch width and length decrease after retention, regardless of treatment expansion or constriction. Two thirds of the patients have unsatisfactory mandibular anterior alignment after retention.[6-8]

Follow-up studies of treated cases show that although the improvement in the dentition, there is a tendency to return toward the original malocclusion many years posttreatment.[2,9] They also report that irregularity increases are slightly greater in patients treated with mandibular premolars extractions and in patients followed up over longer periods of time.[10]

Extraction in orthodontics has remained a subject of controversial debates and speculations over time.[11] However, new century introduced new features into the

orthodontics specialty and new esthetic concepts contributed to reducing the number of cases treated with dental extractions.[11,12] Dardengo et al.[12] stated that the frequency of tooth extraction over a period of 32 years decreased by approximately 20%. But, teeth extraction for orthodontic purposes are still well indicated in many cases.

There is a lack in the literature regarding what kind of treatment will lead to a major stability and what are the dental arch dimension changes when comparing extraction and nonextraction treatments in the long-term. Most of the follow up studies focused on morphologic changes in the mandibular arch evaluating only patients treated nonextraction[7,13-15] or with extraction of pre-molars[6,16-19] because there is an assumption that alignment of mandibular arch serves as a template around which the upper arch develops and functions.[20] There are few studies that focus mainly on changes in the maxillary arch[21,22] and studies that focus on changes in both maxillary and mandibular arches has a mean of 20 years postretention follow-up.[9] Only one study had longer follow up,[23] but the authors evaluated only extraction cases. In addition, follow up studies who compared the stability between nonextraction and extraction treatment evaluated only in short-term[8,24-27] or in the long-term, but no more than 25 years postretention.[1,2,28-37] There is no known study comparing the maxillary and mandibular crowding and dental arch dimensions' relapse between extraction and nonextraction treatments over than 35 years postretention.

The objective of this study is to test the null hypothesis that there is no difference between nonextraction and extraction treatments regarding crowding and dental arch dimensions relapse after 35 years postretention.

MATERIAL AND METHODS

This retrospective study was approved by the Ethics Research Committee of Bauru Dental School, University of São Paulo, Brazil (protocol number: 71629217.5.0000.5417; decision number: 2.268.347) and all subjects signed informed consent.

Sample characteristics

The sample size calculation was based on an alpha significance level of 5% and a beta of 20% to achieve 80% test power to detect a mean difference of 1.3 mm, with a standard deviation of 1.26 for the mandibular irregularity index.[19] Thus, the sample size calculation showed the need for 16 subjects in each group.

The sample was obtained from the files of the Orthodontic Department at Bauru Dental School. From May 2017 to June 2019, the sample was recalled and dental models were obtained (T3).

Sample comprised the dental casts of 57 patients with Class I and Class II malocclusion treated nonextraction or with 4 first premolars extraction. Dental casts were obtained at 3 different stages: pretreatment (T1), posttreatment (T2), an at a mean of 37 years long-term posttreatment (T3). The inclusion criteria were: 1) Class I or Class II malocclusion at the beginning of orthodontic treatment; 2) treatment protocol nonextraction or with extraction of 4 first premolars; 3) complete orthodontic treatment with full maxillary and mandibular fixed appliances (0.022 x 0.028-in slot); 4) all permanent teeth erupted up to the first molars at pretreatment; 5) no tooth agenesis or anomalies; 6) maxillary removable appliance (Hawley plate) worn for 1 year, and mandibular fixed canine-to-canine retainers worn for at least 1 year and a maximum of

3 years posttreatment, without retention at the time of follow-up records. The mean retention time was 2.26 years.

Group 1 comprised 16 subjects (10 girls, 6 boys) treated nonextraction. Mean initial maxillary and mandibular anterior crowding was: 8.54mm (±5.02) and 4.27mm (±2.73), respectively. Mean initial age was 13.10 years (±0.82), mean treatment time was 1.82 years (±0.82) and long-term follow up evaluation time was 35.25 years (±6.11). Six patients presented Class I and 10 had Class II malocclusions.

Group 2 comprised 41 subjects (26 girls, 25 boys) treated with extraction of four first premolars. Mean initial maxillary and mandibular anterior crowding was 9.67mm (±4.11) and 8.82mm (±3.99), respectively. Mean initial age was 13.31 years (±1.97), mean treatment time was 2.32 years (±0.59) and long-term follow up evaluation time was 37.96 years (±4.54). Twenty-three had Class I and 18 presented Class II malocclusions.

In cases treated with extractions, anterior retraction was performed by sliding mechanics with elastic chains. No patient underwent interproximal stripping, rapid maxillary expansion or fiberotomy to avoid postretention rotational relapse as part of the treatment plan. Class II elastics were used when necessary, especially in the Class II malocclusion patients treated with 4 premolars extractions.

Methods

All dental casts were digitized using a R700 3-dimensional scanner (3Shape, Copenhagen, Denmark). Dental casts measurements were performed using the OrthoAnalyzer 3-dimensional software (3Shape A/S, Copenhagen, Denmark). The following measurements were obtained for each set of dental casts: All measurements are linear, in millimeters, and were performed in both maxillary and mandibular arches by a single calibrated examiner (PC).

1. Little Irregularity Index[38] (Figure 1): the sum of the linear displacements of the anatomic contact points of each incisor from the adjacent tooth anatomic contact point.
2. Intercanine width[28] (Figure 2 – black arrows.): linear distance between the cusp tips of the right and left canines.
3. Interpremolar width[28] (Figure 2 – black arrows): linear distance between the cusp tips of the second premolars.
4. Intermolar width[28] (Figure 2 – black arrows.): linear distance between the cusp tips of the first molars.
5. Arch length[39] (Figure 2 – red arrows): perpendicular length from the midpoint between the maxillary and mandibular central incisors to the line drawn between the mesial anatomic contact points of the first molars.
6. Arch perimeter[39] (Figure 2 – yellow arrows): the sum of the 4 segments from mesial aspect of the right permanent first molar to the mesial aspect of the contralateral tooth.

The estimated cusp tips were used in cases with excessive dental wear.[6]

Treatment changes were obtained from T2-T1 values and long-term posttreatment changes, from T3-T2 values. The percentage of relapse of anterior crowding was obtained from the amount of change of irregularity index from T2 to T3 in relation to the amount of correction with treatment (T2-T1).

Error study

A month after the first measurement, 30% of the dental casts were randomly selected and remeasured by the same examiner (PC). Random and systematic errors were calculated according to Dahlberg's formula[40] and with dependent t tests,[41] at $p<0.05$.

Statistical analysis

Normal distribution of the data was checked with Shapiro-Wilk test.

Intragroup comparison of initial (T1), final (T2) and long-term posttreatment (T3) stages was performed with repeated measures ANOVA and Tukey test when necessary.

Intergroup comparability of sex distribution and type of malocclusion was performed with chi-square test. Intergroup comparability of initial, final and posttreatment ages, treatment and posttreatment evaluation times was performed by independent t tests.

Intergroup comparisons of all variables studied in the three stages evaluated (T1, T2, and T3) and the treatment (T2-T1) and long-term posttreatment (T3-T2) changes were performed with independent t tests.

All statistical analyses will be performed using Statistica software (Statistica for Windows, version 10.0, StatSoft Inc., Tulsa, Okla, USA), at $p<0.05$.

RESULTS

The random errors varied from 0.16mm (Md 3-3 width) to 0.58 mm (Mx arch perimeter) and are within the acceptable limits.[27,31] Only one variable showed statistically significant systematic error (Table I).

The groups were comparable regarding ages in all stages, long-term follow up, retention time, distribution of sex and type of malocclusion (Table II). Treatment time was statistically significant longer in the extraction group than in the nonextraction group (Table II).

In the nonextraction group, maxillary anterior crowding was significantly corrected with treatment and showed statistically significant relapse at long-term posttreatment stage (Table III). Maxillary arch length and arch perimeter showed statistically significant decrease from posttreatment to 37 years posttreatment (Table III). Mandibular irregularity index showed statistically significant correction with treatment and showed significant relapse at the long-term evaluation stage, returning to values similar to pretreatment stage (Table III). Mandibular arch length and perimeter showed statistically significant decrease from posttreatment to the long-term stage (Table III).

In the extraction group, maxillary irregularity index was significantly corrected with treatment and showed statistically significant relapse at the long-term stage (Table IV). Maxillary intercanine width showed a statistically significant decrease from posttreatment to the long-term stage (Table IV). Maxillary interpremolar and intermolar widths and maxillary arch length and perimeter decreased significantly with treatment and continued to decrease significantly from posttreatment to the long-term stage (Table IV). Mandibular irregularity index was significantly corrected with treatment and showed a significant relapse at the long-term stage, but not returning to pretreatment values (Table IV). Mandibular intercanine width had statistically significant increase with treatment and significant relapse at the long-term (Table IV). Mandibular interpremolar width significantly decreased with treatment and continued to decrease

significantly at the long-term (Table IV). Mandibular intermolar width had a statistically significant decrease with treatment and remained stable at the long-term (Table IV). Mandibular arch length and perimeter had statistically significant decrease with treatment and continued to decrease significantly at the long-term (Table IV).

The groups were comparable regarding maxillary irregularity index and maxillary and mandibular transversal dimensions at pretreatment (T1)(Table V). Also, mandibular and maxillary arch length were statistically significant greater in the nonextraction group. Mandibular irregularity index was statistically significant greater in the extraction group (Table V).

At posttreatment stage (T2), all dental arch dimensions were statistically significant smaller in the extraction group, except for the maxillary intercanine width, that was statistically significant greater in the extraction group (Table V). At long-term follow up stage (T3), all maxillary and mandibular arch dimensions, except intercanine width were statistically significant smaller in the extraction group (Table V).

Mandibular irregularity index showed statistically greater correction in the extraction group than in nonextraction group (Table VI). Maxillary and mandibular interpremolar and intermolar widths, as well as arch length and arch perimeter showed greater reduction in the extraction group than in nonextraction group (Table VI). The extraction and nonextraction groups showed similar amount of relapse and arch dimension changes in the long-term, except the mandibular arch perimeter, that showed statistically significant greater decrease in the extraction group and the percentage of relapse of mandibular anterior crowding, that was significantly greater in the nonextraction group (Table VI).

DISCUSSION

This is a retrospective study with the long-term evaluation time of almost 40 years posttreatment (mean of 35 years postretention), and is the longest described in the orthodontic literature that we know until now. Most of the similar studies have focused on comparing the nonextraction and premolar extraction techniques with shorter follow-up periods.[8,31,32] Since life expectancy is increasing,[42] it is important for the orthodontists to be aware of the occlusal changes that patients may present over posttreatment time. It must be noted that retrospective studies are necessary as they can give reasonable, ethical and long-term data that can later be used as inclusion/exclusion criteria in RCTs.[1] Furthermore, an RCT with a follow-up period of 40 years can be difficult to conduct.

In this study, digital dental casts were used and the measurements were performed with a digital software. Three-dimensional dental casts' measurement has been an optimal alternative to plaster dental casts with excellent agreement.[43,44]

The groups were comparable regarding several parameters that could influence comparisons: type of malocclusion, ages at all stages, long-term follow up evaluation and retention times, sex distribution and type of malocclusion (Table II). This manner, achieved orthodontic treatment results could be evaluated with increased reliability. Treatment time was statistically significant longer in the extraction group than in the nonextraction group, a mean of 4 to 5 months longer, similar to a previous study' results.[25] It was expected, since it is known that orthodontic treatment performed with premolar extraction are longer than those nonextraction.[45] But some points must be highlighted: the duration of treatment also depends on patient cooperation, treatment objectives, techniques and dentist expertise. The extraction decision is merely one of the clinical variables.[45]

This study showed that maxillary and mandibular arches tended to become more crowded postretention (Figures 2 and 3). Maxillary crowding at T1 was considered severe (8.54mm)[38] in the nonextraction group (Table III). At T2, anterior crowding was corrected with treatment and had minimal irregularity for both arches; both maxillary and mandibular incisors presented significant relapse from T2 to T3; however, maxillary crowding relapsed only 36.04%, while mandibular crowding relapsed 84.47% of the correction, returning close to pretreatment values (Table III). These results are similar to some studies.[7,14,22] However, Sadowsky et al.[14] found different results at T3, that were greater in our study. They found a mean irregularity of 2 and 2.4mm to the maxillary and mandibular arch respectively, and the present study found 3.98mm in the maxillary and 3.78mm in the mandibular arch. This difference could be related to the prolonged retention time in their study (8.4 years) and also due to a long-term follow up observation period in ours. Freitas et al.[7] also found even smaller results for mandibular irregularity at T3, but their postretention follow up was up only 5 years.

Maxillary and mandibular arch length and perimeter remained unchanged from T1 to T2, but decreased significantly at T3 in nonextraction treatments (Table III), probably as a result of the crowding relapse. This is in agreement with a previous study,[46] however there are different results.[13,14] In the study of Sadowsky et al.,[14] the maxillary and mandibular arches were notably expanded, the maxillary more than the mandibular arch, but the mandibular arch presented greater irregularity (5.2mm ±4.16) than the present investigation. This remarkable expansion could be to resolve crowding which caused an increase in arch perimeter.[14,15] In our study, maxillary crowding in nonextraction treatment was solved through maxillary molar distalization with the use of headgears in Class II cases. Mandibular crowding was slight, maybe this is the reason why no change was observed in transversal dimensions in these cases. Other studies show that mandibular intercanine width tends to expand with treatment, and then to contract postretention to approximately the original dimension.[7,35]

The extraction group showed greater amount of anterior crowding for mandibular and maxillary arches at T1 (Table IV), both considered as severe by Little.[38] At T2, anterior crowding was corrected with treatment and presented significant relapse at T3, with minimum to moderate irregularity (3.71mm for maxillary and 4.56mm for mandibular arch), but not returning close to baseline values (Table IV). These results are in agreement with the current orthodontic literature.[6,23] Little's studies[5,6,16,17] indicate that anterior crowding is a continuous phenomenon into the 20-40 ages and likely beyond.

Maxillary intercanine width did not change with extraction treatment and decreased at the long-term (Table IV). An increase is commonly seen in this measurement with treatment, especially in cases with moderate to severe maxillary crowding.[19] However, the canines presented in a labial position, leading to a constriction in this width during treatment in some patients. Erdinc et al.[8] found similar results.

Mandibular intercanine width increased significantly with treatment and presented a significant reduction in the long-term in extraction cases (Table IV). Several studies support this finding.[5,6,24,35] Furthermore, it was expected, since premolars extraction permits distal movements of canines, mainly to solve initial crowding.[35]

Interpremolar, intermolar, arch length and perimeter significantly decreased with treatment with extraction and continued to significantly decrease in the long-term

(Table IV). This was previously demonstrated in the orthodontic literature regarding extraction treatment.[5,6,24,34]

Our results support previous studies that show a significant increase in anterior crowding and a significant reduction in arch dimensions after long-term follow up.[25,29,30] At pretreatment (T1), mandibular anterior crowding was significantly greater in extraction group than in nonextraction (Table V). Other studies showed similar results.[8,29,31] This shows that the extraction decision may be related to the amount of tooth discrepancy present at pretreatment.

Maxillary and mandibular arch length were longer in nonextraction group at T1 (Table V). Artun et al.[29] reported similar results. At posttreatment (T2), maxillary intercanine width was significantly greater in the extraction group (Table V), similar to previous studies.[25,32] This is due to distal movement of the canine during the retraction to solve crowding. However, Gardner and Chaconas[24] reported significant increase in mandibular intercanine width for both nonextraction and extraction groups and Erdinc et al.[8] found that this increase was significant in nonextraction patients. All others maxillary and mandibular dental arch dimensions were significantly reduced in the extraction group both at T2 and T3 (Table V). These results are supported by other authors.[28,31,36] Differently, some authors[29,33] found that extraction cases were more crowded at T3, probably due to individual sample variations and could be related to arch form.

Mandibular irregularity index showed greater correction in the extraction group than in nonextraction group (Table VI). This was expected, since the amount of initial mandibular crowding was greater in the extraction group. Furthermore, as a result of treatment with premolar extractions, interpremolar and intermolar widths, as well as arch length and arch perimeter showed greater reduction in the extraction group than in nonextraction group. It is obvious, because treatment that involves extractions had their arch length during treatment generally decreased. Finally, extraction and nonextraction groups showed similar amount of relapse of anterior crowding.[2,25]

The amount of initial maxillary anterior crowding was similar in both groups (8.84mm in nonextraction cases and 9.67mm in extraction group) and the relapse percentage was also similar in the groups (36.04% in the nonextraction group and 29.13% in the extraction group). However, in the mandibular arch, the extraction cases had greater crowding than nonextraction cases at pretreatment (8.82mm and 4.27mm, respectively), showed similar amount of relapse (3.43mm in extraction cases and 2.61 in nonextraction group), but significantly lower percentage of relapse in the extraction than in the nonextraction group (44.66% and 84.46%, respectively). It highlights the unpredictable character of the anterior crowding relapse. This is in accordance with previous reports.[8,19] Artun et al.[29] reported similar results for mandibular irregularity, despite the amount of crowding in our sample was higher at T1. Luppanapornlarp et al.[32] also found similar results, with no statistically difference in the relapse in both groups, but the relapse rate at T3 in the nonextraction group exceed their baseline values. and the irregularity index at T3 was higher than their baseline values, however this study only evaluate Class II borderline patients.[32] However, Kahl-Nieke et al.[33] found greater relapse of maxillary anterior crowding in the extraction group than the nonextraction and some authors[31,32] rely that both nonextraction and extraction treatment show an essentially identical pattern of posttreatment relapse/settling that are related more to the differential growth of the jaws than to the posttreatment position and orientation of the denture.

Arch dimension changes were similar for both groups in the long-term, except for the mandibular arch perimeter, that showed more decrease in the extraction group

(Table VI). Although not significant, mandibular anterior crowding relapse was greater in the extraction group, and this justifies the greater decrease in the mandibular arch. When evaluating postretention changes, it is of paramount importance to take into account the natural growth aging seen in untreated subjects. There are several studies reporting this maturational changes,[11,37,39,47-49] indicating a decrease in arch length and perimeter and an increase in anterior alignment. Abdulraheem et al.[50] stated that as about 25% of the displaced incisors can be considered as an effect of natural growth, not a relapse of the orthodontic treatment. The majority claim that the changes found in a sample of untreated normal were similar in nature but lesser in extent than postretention changes found in a sample of treated cases.[13,47,49]

Clinical implications

With increasing life expectancy, orthodontists expect that the treatment results remain stable for many years. With the findings of this study, orthodontists will be able to plan an efficient retention protocol, as well as explain to the patient the changes that may occur in their occlusion along many years' posttreatment, irrespective of the type of treatment, with or without extractions.

Despite of similar amount of relapse, the percentage of relapse of mandibular anterior crowding was greater in the nonextraction cases than in extraction patients. The slight mandibular crowding at pretreatment relapsed almost returning to the initial values in the nonextraction cases and less than half of the initial value in the extraction group, even presenting similar values in the long-term evaluation stage.

Besides that, if patients want their teeth aligned over time, lifelong retention is strongly recommended.

CONCLUSIONS

- There was no difference in the amount of relapse of anterior crowding in cases treated with and without extraction after more than 35 years posttreatment.
- The percentage of maxillary anterior crowding relapse was similar in both groups; 36.04% for the nonextraction group and 29.13% in the extraction group. However, the percentage of relapse of mandibular anterior crowding was higher in the nonextraction (84.46%) than in the extraction group (44.66%).
- There was no difference in the long-term relapse of transversal arch dimensions in cases treated with and without extractions.
- Mandibular arch perimeter showed more decrease in the long-term in extraction cases.

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LEGEND TO THE FIGURES

Fig. 1: Maxillary and mandibular Little Irregularity Index.

Fig. 2: Arch dimensions (3-3, 5-5 and 6-6 width: Black arrows; Arch length: red arrows; Arch Perimeter: yellow arrows).

Fig. 3: Anterior crowding relapse in nonextraction treatment (T1: Pretreatment; T2: Posttreatment and T3: 39 years posttreatment).

Fig. 4: Anterior crowding relapse in extraction treatment (T1: Pretreatment; T2: Posttreatment and T3: 41 years posttreatment).

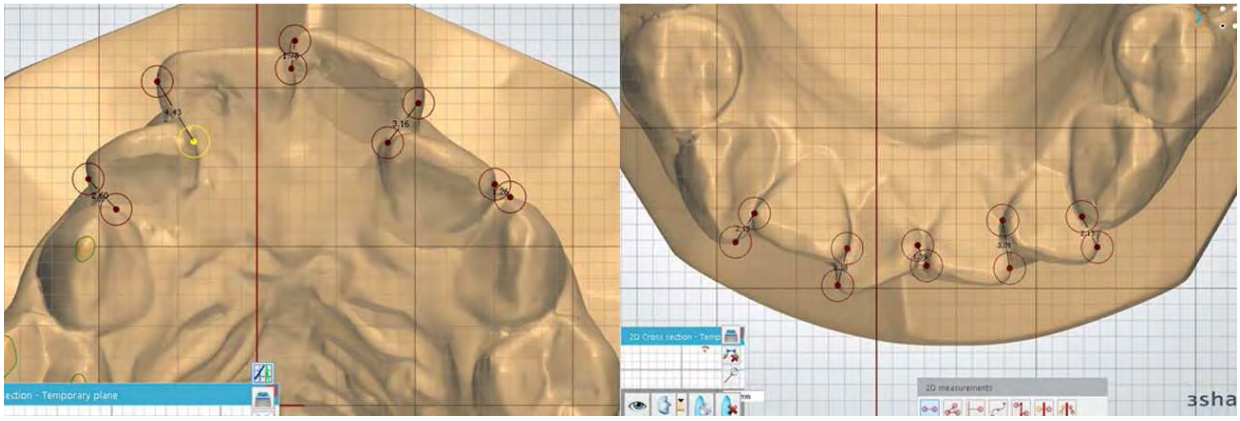

Fig. 1

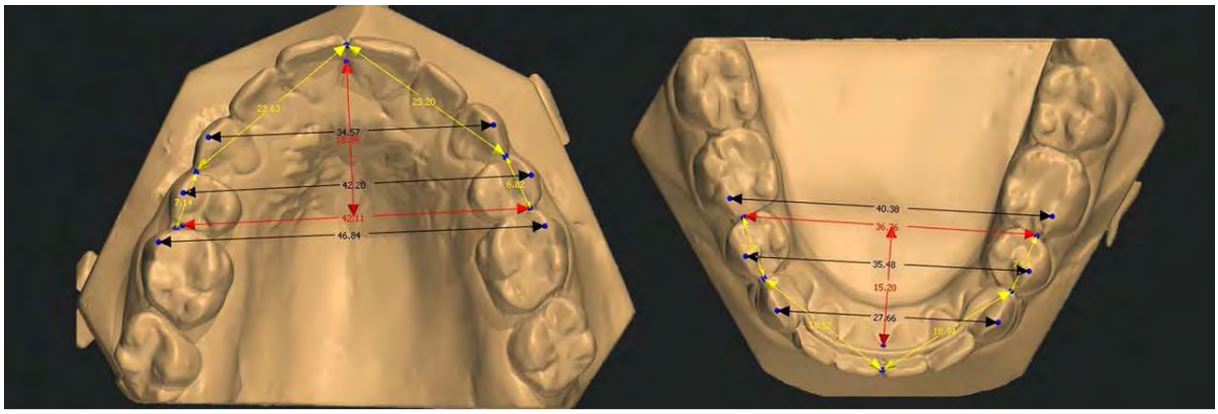

Fig. 2

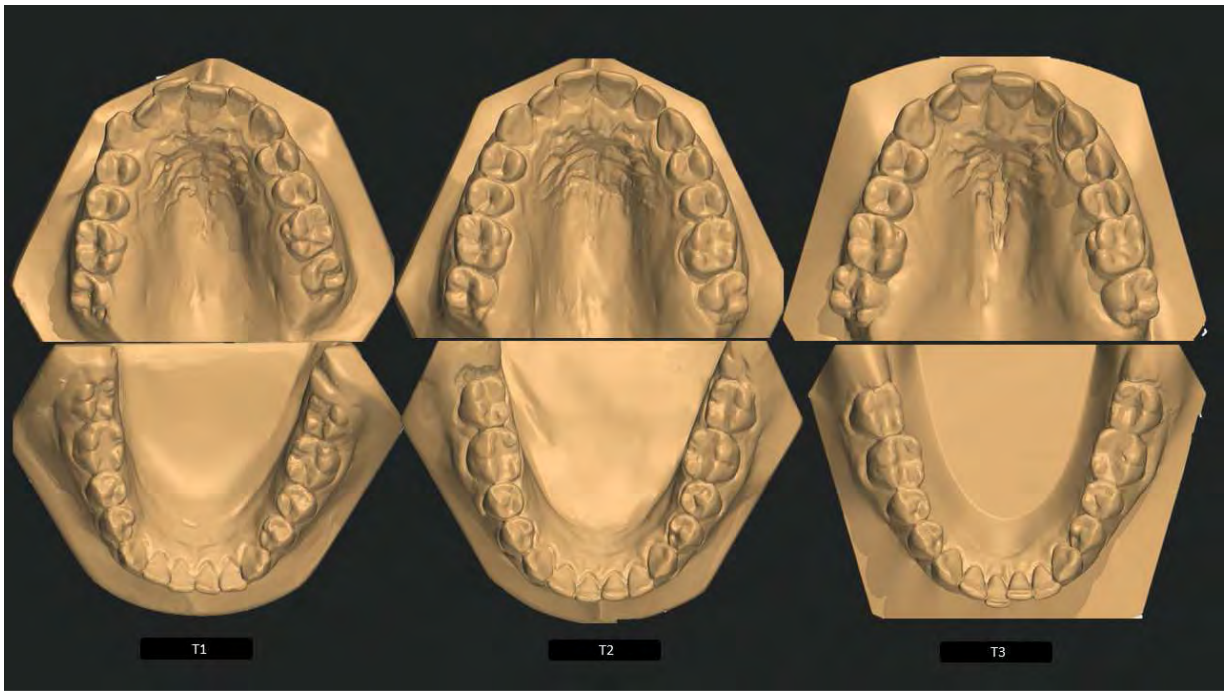

Fig. 3

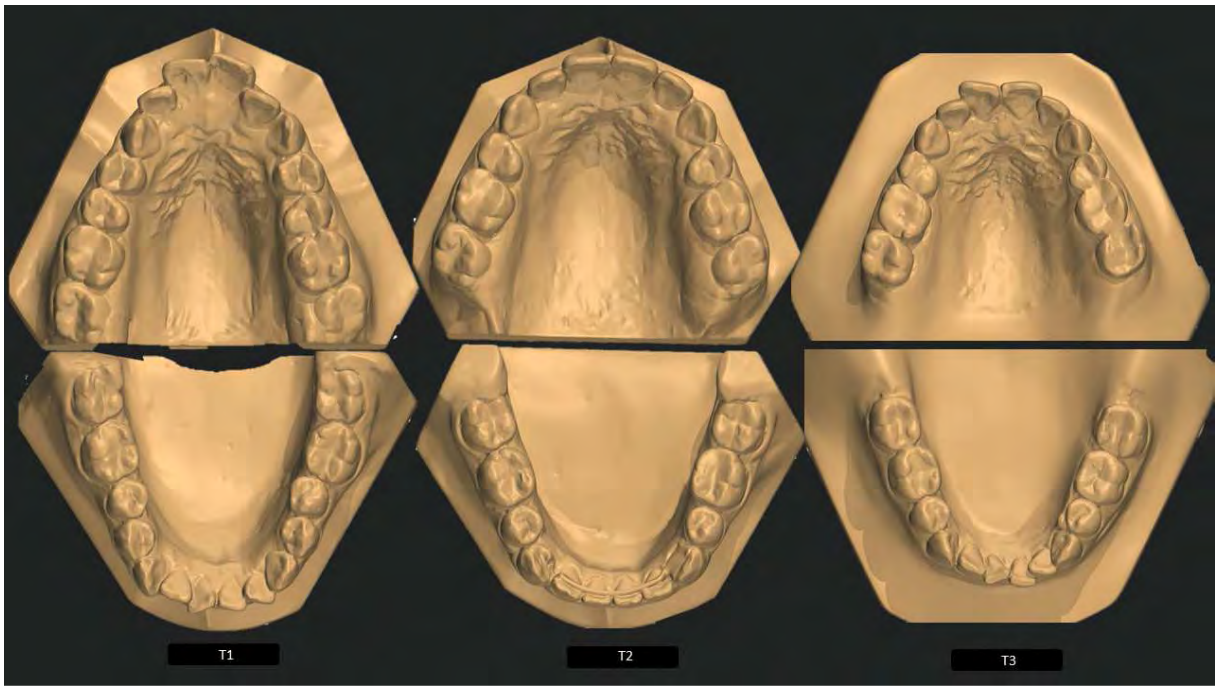

Fig. 4

Table I. Results of the error study (Dahlberg formula – casual errors and dependent t tests – systematic errors).

Variables (mm)	**1st Measurement (N=37)**		**2nd Measurement (N=37)**		**Dahlberg**	**P**
	Mean	**SD**	**Mean**	**SD**		
Maxillary dental casts measurements						
Mx Little	4.42	4.40	4.45	4.19	0.41	0.821
Mx 3-3 width	33.83	2.42	33.81	2.49	0.21	0.750
Mx 5-5 width	43.20	2.84	43.19	2.49	0.19	0.835
Mx 6-6 width	48.90	2.44	48.77	2.47	0.25	**0.031***
Mx arch length	22.84	3.88	22.90	3.84	0.18	0.121
Mx arch perimeter	66.85	6.37	67.70	6.42	0.58	0.254
Mandibular dental casts measurements						
Md Little	4.71	3.99	4.59	3.82	0.46	0.253
Md 3-3 width	26.03	1.67	26.00	1.71	0.16	0.419
Md 5-5 width	36.84	2.90	36.76	2.94	0.26	0.193
Md 6-6 width	42.16	2.46	42.04	2.47	0.26	0.077
Md arch length	18.13	3.36	18.05	3.32	0.18	0.081
Md arch perimeter	57.70	7.15	57.70	7.08	0.36	0.964

*Statistically significant at $P<0.05$

Table II. Results of intergroup comparability of the ages and treatment time, long-term follow up evaluation and retention times (independent t tests), sex distribution and type of malocclusion (chi-square tests).

Variables	**GROUP 1 NONEXTRACTION (N=16)**		**GROUP 2 EXTRACTION (N=41)**		**P**
	Mean	**SD**	**Mean**	**SD**	
Age T1	13.20	0.82	13.31	1.97	0.841 £
Age T2	15.070	1.16	15.63	2.14	0.322 £
Age T3	50.32	6.05	53.60	5.51	0.054 £
Treatment Time	1.86	0.82	2.32	0.59	**0.022*** £
Long-term follow-up evaluation time	35.25	6.11	37.96	4.54	0.071 £
Retention time	2.26	1.17	2.26	1.26	0.983 £
Sex					X^2 =0.004
Males	6		15		DF= 1
Females	10		26		P=0.948 ¥
Type malocclus.					X^2 =1.592
Class I	6		23		DF= 1
Class II	10		18		P=0.206 ¥

* Statistically significant at P<0.05
£ independent t test
¥ chi-square test

Table III. Results of the comparison of initial, final and long-term posttreatment stages of the Nonextraction group (repeated measures ANOVA and Tukey tests).

Variables (mm)	T1	T2	T3	P
	Mean (SD)	Mean (SD)	Mean (SD)	
Maxillary dental casts measurements				
Mx Little	8.54 (5.02)^{A}	1.40 (1.07)^{B}	3.98 (2.35)^{C}	**0.000***
Mx 3-3 width	33.93 (2.70)	33.59 (1.57)	33.59 (1.73)	0.865
Mx 5-5 width	44.85 (4.06)	46.60 (2.32)	46.18 (2.63)	0.116
Mx 6-6 width	48.88 (4.03)	50.57 (2.67)	50.44 (2.81)	0.214
Mx arch length	26.98 (2.76)^{A}	25.91 (1.69)^{A}	23.83 (1.24)^{B}	**0.000***
Mx arch perimeter	75.23 (3.84)^{A}	75.17 (3.69)^{A}	71.73 (2.57)^{B}	**0.000***
Mandibular dental casts measurements				
Md Little	4.27 (2.73)^{A}	1.17 (0.89)^{B}	3.78 (2.18)^{A}	**0.000***
Md 3-3 width	26.57 (1.76)	26.67 (2.81)	25.52 (2.24)	0.217
Md 5-5 width	39.04 (3.52)	39.53 (1.96)	39.14 (4.06)	0.678
Md 6-6 width	44.02 (3.55)	43.58 (2.63)	44.50 (2.95)	0.264
Md arch length	22.09 (1.50)^{A}	21.71 (1.27)^{A}	20.02 (1.03)^{B}	**0.000***
Md arch perimeter	65.65 (3.88)^{A}	65.37 (3.04)^{A}	63.16 (3.33)^{B}	**0.016***

* Statistically significant at $P<0.05$

Different letters in a row indicate the presence of a statistically significant difference between the treatment stages.

Table IV. Results of the comparison of initial, final and long-term posttreatment stages of the Extraction group (repeated measures ANOVA and Tukey tests).

Variables (mm)	T1	T2	T3	P
	Mean (SD)	Mean (SD)	Mean (SD)	
Maxillary dental casts measurements				
Mx Little	9.67 (4.11)^{A}	1.25 (1.17)^{B}	3.71 (2.31)^{C}	**0.000***
Mx 3-3 width	34.56 (2.52)^{AB}	34.98 (1.72)^{A}	34.12 (2.12)^{B}	**0.004***
Mx 5-5 width	44.05 (2.65)^{A}	43.08 (1.82)^{B}	41.76 (2.10)^{C}	**0.000***
Mx 6-6 width	49.25 (2.29)^{A}	48.06 (2.16)^{B}	47.42 (2.42)^{C}	**0.000***
Mx arch length	25.34 (2.57)^{A}	20.21 (1.70)^{B}	18.27 (1.70)^{C}	**0.000***
Mx arch perimeter	73.64 (4.26)^{A}	63.15 (2.86)^{B}	60.00 (3.21)^{C}	**0.000***
Mandibular dental casts measurements				
Md Little	8.82 (3.99)^{A}	1.13 (0.91)^{B}	4.56 (2.86)^{C}	**0.000***
Md 3-3 width	26.31 (2.17)^{A}	27.18 (1.22)^{B}	25.54 (1.66)^{C}	**0.000***
Md 5-5 width	38.28 (2.42)^{A}	35.89 (1.62)^{B}	34.61 (2.13)^{C}	**0.000***
Md 6-6 width	43.71 (2.45)^{A}	41.30 (2.29)^{B}	41.72 (2.75)^{B}	**0.000***
Md arch length	20.85 (1.92)^{A}	16.51 (1.62)^{B}	14.17 (1.67)^{C}	**0.000***
Md arch perimeter	64.41 (3.50)^{A}	54.10 (2.86)^{B}	50.09 (2.74)^{C}	**0.000***

* Statistically significant at $P<0.05$

Different letters in a row indicate the presence of a statistically significant difference between the treatment stages

Table V. Results of intergroup comparison of initial (T1), final (T2) and long-term posttreatment stages (T3)(independent t tests).

Variables (mm)	GROUP 1 NONEXTRACTION (N=16)		GROUP 2 EXTRACTION (N=41)		P
	Mean	SD	Mean	SD	
T1 – Initial					
Maxillary dental casts measurements					
Mx Little	8.54	5.02	9.67	4.11	0.384
Mx 3-3 width	33.93	2.70	34.56	2.52	0.409
Mx 5-5 width	44.85	4.06	44.05	2.65	0.384
Mx 6-6 width	48.88	4.03	49.25	2.29	0.667
Mx arch length	26.98	2.76	25.34	2.57	**0.038***
Mx arch perimeter	75.23	3.84	73.64	4.26	0.199
Mandibular dental casts measurements					
Md Little	4.27	2.73	8.82	3.99	**0.000***
Md 3-3 width	26.57	1.76	26.31	2.17	0.667
Md 5-5 width	39.04	3.52	38.28	2.42	0.354
Md 6-6 width	44.02	3.55	43.71	2.45	0.703
Md arch length	22.09	1.50	20.85	1.92	**0.024***
Md arch perimeter	65.65	3.88	64.41	3.50	0.249
T2 – Final					
Maxillary dental casts measurements					
Mx Little	1.40	1.07	1.25	1.17	0.659
Mx 3-3 width	33.59	1.57	34.98	1.72	**0.007***
Mx 5-5 width	46.60	2.32	43.08	1.82	**0.000***
Mx 6-6 width	50.57	2.67	48.06	2.16	**0.000***
Mx arch length	25.91	1.69	20.21	1.70	**0.000***
Mx arch perimeter	75.17	3.69	63.15	2.86	**0.000***
Mandibular dental casts measurements					
Md Little	1.17	0.89	1.13	0.91	0.886
Md 3-3 width	26.67	2.81	27.18	1.22	0.344
Md 5-5 width	39.53	1.96	35.89	1.62	**0.000***
Md 6-6 width	43.58	2.63	41.30	2.29	**0.002***
Md arch length	21.71	1.27	16.51	1.62	**0.000***
Md arch perimeter	65.37	3.04	54.10	2.86	**0.000***
T3 - Long-term posttreatment					
Maxillary dental casts measurements					
Mx Little	3.98	2.35	3.71	2.31	0.695
Mx 3-3 width	33.59	1.73	34.12	2.12	0.381
Mx 5-5 width	46.18	2.63	41.76	2.10	**0.000***
Mx 6-6 width	50.44	2.81	47.42	2.42	**0.000***
Mx arch length	23.83	1.24	18.27	1.70	**0.000***
Mx arch perimeter	71.73	2.57	60.00	3.21	**0.000***
Mandibular dental casts measurements					
Md Little	3.78	2.18	4.56	2.86	0.354
Md 3-3 width	25.52	2.24	25.54	1.66	0.982
Md 5-5 width	39.14	4.06	34.61	2.13	**0.000***
Md 6-6 width	44.50	2.95	41.72	2.75	**0.001***
Md arch length	20.02	1.03	14.17	1.67	**0.000***
Md arch perimeter	63.16	3.33	50.09	2.74	**0.000***

* Statistically significant at P<0.05

Table VI. Results of intergroup comparison of treatment changes (T2-T1) and long-term posttreatment changes (T3-T2)(independent t tests).

Variables (mm)	GROUP 1 NONEXTRACTION (N=16)		GROUP 2 EXTRACTION (N=41)		P
	Mean	**SD**	**Mean**	**SD**	
T2-T1 – Treatment Changes					
Maxillary dental casts measurements					
Mx Little	-7.13	5.41	-8.41	3.78	0.315
Mx 3-3 width	-0.33	2.82	0.42	2.58	0.335
Mx 5-5 width	1.74	3.22	-0.97	2.16	**0.000***
Mx 6-6 width	1.68	3.56	-1.18	1.97	**0.000***
Mx arch length	-1.07	3.45	-5.13	2.88	**0.000***
Mx arch perimeter	-0.06	4.93	-10.48	3.62	**0.000***
Mandibular dental casts measurements					
Md Little	-3.09	2.67	-7.68	4.24	**0.000***
Md 3-3 width	0.10	2.06	0.87	2.19	0.231
Md 5-5 width	0.48	2.51	-2.38	2.37	**0.000***
Md 6-6 width	-0.43	2.49	-2.40	2.41	**0.008***
Md arch length	-0.37	1.35	-4.33	1.92	**0.000***
Md arch perimeter	-0.28	2.44	-10.31	3.71	**0.000***
T3-T2 – Long-term Posttreatment Changes					
Maxillary dental casts measurements					
Mx Little	2.57	1.86	2.45	1.81	0.826
% of relapse (Mx Little)	36.04%		29.13%		0.612
Mx 3-3 width	0.00	1.36	-0.86	1.57	0.059
Mx 5-5 width	-0.42	1.57	-1.31	1.55	0.057
Mx 6-6 width	-0.13	1.29	-0.64	1.24	0.173
Mx arch length	-2.08	1.39	-1.93	1.48	0.732
Mx arch perimeter	-3.44	2.30	-3.15	2.33	0.670
Mandibular dental casts measurements					
Md Little	2.61	1.77	3.43	2.73	0.272
% of relapse (Md Little)	84.46%		44.66%		**0.003***
Md 3-3 width	-1.15	3.05	-1.64	1.45	0.409
Md 5-5 width	-0.39	2.90	-1.27	1.66	0.153
Md 6-6 width	0.91	2.07	0.42	2.51	0.490
Md arch length	-1.69	0.84	-2.33	1.35	0.082
Md arch perimeter	-2.20	2.57	-4.00	2.63	**0.023***

* Statistically significant at P<0.05

Article 2

TREATMENT OUTCOMES, LONG-TERM COMPARISON OF OCCLUSAL RELAPSE AND PATIENT SATISFACTION IN CASES TREATED WITH AND WITHOUT EXTRACTIONS

ABSTRACT

Objective: To compare the treatment outcomes, long-term occlusal relapse and patient satisfaction between nonextraction and extraction cases after 37 years posttreatment. **Material and Methods:** Sample comprised 57 Class I and II malocclusion patients divided into 2 groups: G1: 16 patients treated nonextraction, with mean initial, final and long-term posttreatment ages of 13.20, 15.07 and 50.32 years, respectively. Mean treatment time and long-term follow-up time were 1.86 and 35.25 years, respectively. G2: 41 patients treated with extraction of 4 first premolars, with mean initial, final and long-term posttreatment ages of 13.31, 15.63 and 53.60 years, respectively. Mean treatment and long-term follow up times were 2.32 and 37.96 years, respectively. The PAR and OGS indexes were evaluated at pretreatment (T1), posttreatment (T2) and long-term posttreatment (T3) stages. The subjects also answered an on-line questionnaire regarding esthetic and occlusal self-perception at T3. Intra and intergroup comparisons were performed with repeated measures ANOVA/Tukey and independent t-tests, respectively. **Results**: PAR index improved with treatment and relapsed at the long-term similarly in both groups. Both groups had OGS scores close to the passing score at T2. Nonextraction group showed greater relapse according to OGS than extraction cases. Nonextraction patients perceived more changes in alignment over time than extraction individuals, but overall satisfaction was similar. **Conclusions:** PAR index improved with treatment and PAR and OGS showed significant increase indicating relapse in the long-term. The nonextraction group showed more occlusal relapse and perceived more changes in alignment over time, but overall patient satisfaction was similar for both groups.

Keywords: treatment outcomes, tooth extraction, stability, relapse, objective grading system.

INTRODUCTION

If dental professionals were asked about their orthodontic treatment goals, they might mention pleasant smiles, good occlusal function and mainly stability of the results obtained over the years. Long-term stability of orthodontic treatment has been extensively studied and difficult to predict.[1-3]

Dental occlusion is dynamic. Changes will occur regardless of the technique, appliance and treatment protocol used. These changes can be desired by the orthodontist, called “settling of the occlusion”[4] or not, causing great discomfort for the clinician and the patient, the much-feared “relapse”. It is of paramount importance to determine if some trait of the orthodontic treatment might improve or worsen over time.

The evaluation of the orthodontic treatment outcomes for a long time was subjective, so in this context, the orthodontists’ experience determined his success or failure. The ideal parameter for orthodontic treatments finishing was based on the six keys to normal occlusion.[5] The use of objective criteria is essential to uniformly quantify

and measure the severity of malocclusions, the efficacy of different treatment modalities as well to assess the relapse of orthodontic treatments.[6] Attempts have recently been made to evaluate treatments in a more objective way,[7] allowing clinicians worldwide to speak the same language regarding the orthodontic treatment outcomes. In this context, the Peer Assessment Rating (PAR index) and the American Board of Orthodontics Objective Grading System (OGS) are two of the most used indexes to evaluate treatment outcomes and stability.[8-11]

The PAR Index was developed to measure treatment outcomes in orthodontics[9,10] and its validity was improved by weighting the scores of some components to reflect their relative importance.[8] It evaluates tooth alignment, dental impaction, relationships of the buccal segments, overjet, overbite and midline discrepancies. The greater the mean percentage reduction in the PAR score, the greater the finishing achieved by the orthodontic treatment.

More recently, in order to assess the adequacy of finished orthodontic results, The American Board of Orthodontics (ABO) developed a model grading system (Objective Grading System OGS) as an occlusal index to evaluate posttreatment dental casts.[11] It assesses the final occlusion according to 8 different occlusal components: alignment, marginal ridges, buccolingual inclination, occlusal relationships, occlusal contacts, overjet, interproximal contacts, and root angulation. A metal gauge commercialized by the ABO is used to measurements.

Although treatments with teeth extraction have declined in recent years,[12] a controversy still exists regarding differences in treatment outcomes and stability when patients treated with and without extractions are compared. Long-term posttreatment stability of cases treated with and without extraction is variable and unpredictable.[13,14] There is a lack in the orthodontic literature regarding long-term occlusal stability between treatments performed nonextraction and with extractions and patient satisfaction over time.

It was extensively previously demonstrated in the orthodontic literature that the great majority of the long-term studies is focused in the functional and esthetic parameters and some kind of deviations from the normal. Recently, researches changed their focus toward the patient perspective of the orthodontic treatment and their correlated satisfaction and quality of life.[15] Studies show that orthodontic treatment promotes greater psycho-emotional and social benefits.[15,16] AlQurani et al.[17] found that orthodontic treatment in adolescents besides promoting health-related behavioral change, dental health and psychosocial influences, also lead to an improvement in self-confidence, self-esteem, social interactions and social acceptance, therefore supporting the quality of life benefits of orthodontic treatment, however, there is no known study evaluating patient satisfaction regarding orthodontic treatment more than 35 years postretention.

So, the objective of this study was to compare the outcomes and the long-term occlusal stability between patients treated with and without extractions using the PAR and OGS indexes, as well as patient satisfaction in the long-term.

MATERIAL AND METHODS

This retrospective study was approved by the Ethics Research Committee of Bauru Dental School, University of São Paulo, Brazil (protocol number:

71629217.5.0000.5417; decision number: 2.268.347) and all subjects signed informed consent.

Sample characteristics

The sample size calculation was based on an alpha significance level of 5% and a beta of 20% to achieve 80% test power to detect a minimum difference of 1.5, with a standard deviation of 1.4, for the alignment component of the OGS.[18] Thus, the sample size calculation showed the need for at least 15 subjects in each group.

The retrospective sample was obtained from the files of the Orthodontic Department at Bauru Dental School, University of São Paulo. From May 2017 to June 2019, the subjects were recalled and dental casts and radiographs were obtained (T3). The inclusion criteria were: 1) Class I or Class II malocclusion at the beginning of orthodontic treatment; 2) treatment protocol nonextraction or with extraction of 4 first premolars; 3) complete orthodontic treatment with full maxillary and mandibular fixed edgewise appliances (0.022 x 0.028-in slot); 4) all permanent teeth erupted up to the first molars irrupted before the beginning of treatment; 5) no tooth agenesis or anomalies; 6) maxillary removable appliance (Hawley plate) worn for 1 year, and mandibular fixed canine-to-canine retainers worn for at least 1 year and a maximum of 3 years after treatment, without retention at the time of follow-up records.

The sample comprised 57 patients with Class I and Class II malocclusion treated orthodontically nonextraction or with 4 first premolars extraction. Dental casts and panoramic radiographs were evaluated, obtained at three different time points: pretreatment (T1), posttreatment (T2), at the long-term, a mean of 37 years posttreatment (T3).

The sample was divided into 2 groups:

Group 1 comprised 16 subjects (10 girls, 6 boys) treated nonextraction. Six patients presented Class I and 10 Class II malocclusions. Mean initial age was 13.10 years (±0.82), mean treatment time was 1.82 years (±0.82) and long-term follow-up evaluation time was 35.25 years (±6.11).

Group 2 comprised 41 subjects (26 girls, 25 boys) treated with extraction of four first premolars. Twenty-three presented Class I and 18 had Class II malocclusion. Mean initial age was 13.31 years (±1.97), mean treatment time was 2.32 years (±0.59) and long-term follow-up evaluation time was 37.96 years (±4.54).

Figures 1 and 2 show the dental casts of the 3 stages (T1, T2 and T3) of a nonextraction and an extraction case presenting occlusal traits relapse.

Methods

The PAR Index[9,10] was developed to record the malocclusion at any stage of treatment. The individual scores are summed to obtain an overall total, representing the degree a case deviates from normal alignment and occlusion. The dental arch is divided into three recording segments: left buccal, right buccal and anterior (Figure 3). The following occlusal features are evaluated in both arches: Buccal occlusion on the right and left sides (antero-posterior relationship, vertical and transverse), overjet, overbite, crowding, spacing, impacted teeth and centerline. A score of zero means that a perfect occlusion was reached; a score from one to nine indicates that good dental relationships are present; a score above 10 indicates that there are a residual malocclusion and above 40, severe malocclusion.[19] The American PAR weighting was

used; it eliminates mandibular anterior alignment.[8] The weightings are: 5 for overjet, 3 for overbite and midline discrepancy, 2 for buccal occlusion and 1 for maxillary anterior alignment.[8] The measurements were performed with the PAR ruler and a digital caliper (Mitutoyo America, Aurora, Ill, USA)(Figure 4).

The OGS was developed by the American Board of Orthodontics (ABO) to evaluate the quality of orthodontically treated occlusions.[11] The ABO OGS contains eight criteria: alignment, marginal ridges, buccolingual inclination, occlusal relationships, occlusal contacts, overjet, interproximal contacts and root angulation that are evaluated using dental casts. A specific metal gauge is used to perform the measurements (ABO Measuring gauge, St. Louis, MO, USA) (Figure 5). A score of 0 indicates ideal alignment and occlusion; scores of 1 and 2 show deviations from the normal. The score for each patient indicates the relative deviations from the ideal score. The final calculation will be made by the sum of points in each of the criteria and noted in a paper sheet (Figure 6). The critical score for the ABO clinical examination is 30.[11] As OGS is used to evaluate treatment outcomes, T2, T3 and the difference from the long-term posttreatment stage with the final stage (T3-T2) were evaluated.

All measurements were performed by one calibrated and blinded examiner (PC).

The satisfaction questionnaire was sent by WhatsApp and allowed for comments in certain occlusal traits (Figure 7). Issues addressed were scored about the patients' own teeth and smile at follow-up stage.[20] To those who did not respond promptly, new messages were resent after 24 and 36 hours. Answers were recorded and compared.

Error study

A month after the first measurement, 30% of the sample were randomly selected and remeasured by the same examiner (PC). Random and systematic errors were calculated according to Dahlberg's formula[21] and with dependent t tests,[22] at $p<0.05$.

Statistical analysis

The normal distribution of the data was checked using the Shapiro-Wilk test.

Intragroup comparison of initial (T1), final (T2) and long-term posttreatment (T3) stages was performed with repeated measures ANOVA and Tukey test when necessary.

Intergroup comparability of sex distribution and type of malocclusion was performed with the chi-square test. Intergroup comparability of initial, final and posttreatment ages, treatment, follow-up and retention times were performed by independent t tests.

Intergroup comparison of the variables studied at the three stages evaluated (T1, T2, and T3) and the treatment (T2-T1) and long-term posttreatment (T3-T2) changes were performed with independent t tests.

All statistical analyses were performed with Statistica software (Statistica for Windows, version 10.0, StatSoft Inc., Tulsa, Okla, USA), at $p<0.05$.

RESULTS

The random errors varied from 1.17 (PAR Index) to 1.83 (OGS) and were within the acceptable ranges.[23,24] There was no significant systematic error (Table I).

The groups were comparable regarding ages in all stages, long-term follow-up and retention times as well as distribution of sex and type of malocclusion (Table II). Treatment time was statistically significant longer in the extraction than in the nonextraction group (Table II).

PAR index was statistically significant improved with treatment and showed statistically significant worsening indicating occlusal relapse at the long-term posttreatment stage in both nonextraction and extraction groups (Table III).

Nonextraction group had a mean OGS score of 31.81 (±9.46) at posttreatment and had a significantly worsening at long-term posttreatment stage (41.00±19.36)(Table IV). Alignment, buccolingual inclination and occlusal relationship showed statistically significant relapse at the long-term posttreatment stage. Marginal ridges significantly improved in the long-term (Table IV).

Extraction group had a mean OGS score of 31.14 (±5.68) at posttreatment and showed significant increase, indicating occlusal relapse at the long-term posttreatment stage (33.82±10.06)(Table IV). Alignment and occlusal relationship showed statistically significant relapse at the long-term stage, while marginal ridges, occlusal contacts and interproximal contacts significantly improved at long-term (Table IV).

The groups were comparable regarding the malocclusion severity (PAR Index) at T1 (Table V). Nonextraction and extraction treatments showed similar results at posttreatment regarding PAR and OGS indexes (Table V). Marginal ridges and buccolingual inclination showed significant lower scores in the extraction group at T2. At the long-term (T3), the scores of the occlusal indexes were similar in nonextraction and extraction treatment; only the buccolingual inclination and root angulation components of the OGS showed statistically significant greater scores in the nonextraction group (Table V).

The treatment effects and occlusal relapse were similar in the nonextraction and extraction groups according to PAR Index (Table VI). The nonextraction group showed significantly greater relapse according to the OGS score (Table VI). The nonextraction group showed a significantly greater improvement in the marginal ridges than the extraction group (Table VI). Occlusal relationship showed a significantly greater relapse in the nonextraction group (Table VI). Interproximal contacts improved in the extraction group and slightly worsened in the nonextraction group (Table VI).

Regarding patient satisfaction questionnaire, about 72% of the all patients responded and scored approximately 8.35 to the satisfaction with their smile, on a scale from 1 to 10 (Table VII). There was no difference regarding patient satisfaction, smile score, main complain about actual smile and the discomfort caused by the crowding in the nonextraction and extraction groups (Table VII). Patients in the nonextraction group perceived more changes in their anterior alignment over time than the extraction group (Table VII).

DISCUSSION

Previous studies have evaluated treatment outcomes and postretention results of extraction vs nonextraction treatment regarding long-term stability and treatment time.[1,19,23] Limited information exists on the evaluation of the 2 treatment approaches using the ABO OGS index.[25-30]. Long-term studies using OGS have a mean of 10 years postretention, do not specify treatment protocol and excluded some occlusal components.[31]. The only study that specify both treatment types had a mean of 12.7

years postretention and excluded the root angulation component.[32] To the best of our knowledge, this seems to be the first study that compared the occlusal relapses between nonextraction and extraction treatments more than 35 years postretention using the PAR and OGS indexes.

Although the sample is small in the nonextraction group, it is substantial, because the subjects were evaluated more than 35 years after postretention. According to Otuyemi and Jones,[33] there are several reasons besides the long-term follow up that lead to a low response rate to recall, as lack of incentive to take time off from work, patients who were happy with the treatment outcome and had fairly stable results, and those that had substantial relapse and possibly retreated.

When evaluating the orthodontic treatment outcomes and stability, it is necessary to determine the changes from pretreatment to posttreatment stages, as well as to match the malocclusion severity at the beginning. The OGS system,[11] although highly sensitive to determine occlusal traits, scores only the treatment results. So, to ensure great reliability, the PAR index[8,10] was also used, to quantify the malocclusion severity and the improvement with treatment.

The groups matched regarding ages in all stages, long-term follow-up evaluation and retention times as well as distribution of sex and type of malocclusion (Table II). Treatment time was statistically significant longer in the extraction than in the nonextraction group, which agrees with previous studies.[19,26,34,35] Extraction treatment demands more time to solve crowding and to close spaces. Moreover, the groups also presented similar malocclusion severity according to the PAR index at pretreatment (Table V).

Treatment outcomes were considered “greatly improved” for both groups according to the PAR Index.[10] In both groups, the initial PAR score was significantly corrected with treatment and showed a significant increase in the long-term, indicating a significant occlusal relapse, but not returning close to pretreatment values (Table III). Nonextraction and extraction cases showed, respectively, a mean relapse of 25.33% and 21.45% of the correction achieved with treatment, evaluated by the PAR index. This result is in agreement with Freitas et al.[1] when evaluating extraction cases. Birkeland et al.[36] found similar results 5 years postretention, but nonextraction and extraction cases were mixed in the sample. Other authors[23,33] found a higher relapse rate (48.6%) 10 years after retention, however they used the unweighted PAR and did not specify the treatment protocol.

Both groups also showed similar treatment outcomes at posttreatment and long-term follow-up regarding PAR and OGS indexes (Table V). There is no consensus in the literature regarding this comparability. Holman et al.[19] found higher PAR scores at T1 in extraction than in nonextraction cases, but both groups were statistically similar at posttreatment stage. Some authors[26,35] found better occlusal results at T2 in the extraction group while Cansunar et al.[37] found a better finishing in nonextraction patients. Our result is in agreement with Mislik et al.[28], who did not found difference between nonextraction and extraction protocols at T2.

Overall, nonextraction and extraction groups showed similar treatment results (T2-T1) and relapse (T3-T2) according to PAR index (Table VI).This was previous demonstrated.[38] The relapse rates of 25.33% and 21.45% in nonextraction and extraction groups were very similar, whereas the OGS scores showed greater relapse in nonextraction treatment (Table VI). At T3, nonextraction group had a mean OGS

score of 41.00 while the extraction group had a mean of 33.82, very close to the passing score. So, it is possible to conclude that the PAR index is not very sensitive and does not assess minor discrepancies in tooth positions, but it is superior for evaluatin therapeutic improvement from T1 to T2.[30] Additionally, ABO-OGS measures individual teeth based on the deviation distance (mm), while PAR analyses segment units, based on definitions like: “one-quarter to one half lower incisor width”.[39] Due to this, treatment changes from posttreatment to postretention will be discussed below according to the OGS index.

Nonextraction and extraction treatments had OGS scores close to the ABO passing scores (30), indicating good finishing (Table IV). Alignment and occlusal relationship significantly worsened in both groups at T3 (Table IV). Alignment relapse was previously demonstrated.[31,32] The studies found that this was the only criterion with less predictable change.[40,41] It could be speculated that the relapse of occlusal relationship in the nonextraction group is due to the presence, although not significant, of more Class II than Class I patients. Correction of Class II malocclusion in nonextraction patients can be accounted by cervical headgear and intermaxillary Class II elastics and are quite stable over the years.[42,43] However, in this study the long follow-up time may have been partially responsible for this relapse. In the extraction cases, this minimum relapse could be due to the anchorage loss, buccal inclination of the maxillary and lingual inclination of the mandibular incisors that are evident in long-term extraction cases, caused by the effects of “en masse” retraction.[44] Yang-Powers et al.[25] and Aszkler et al.[32] stated that overjet often improves with time. On the other hand, Uhde et al.[45] found that posttreatment changes in overjet were unrelated to the type of malocclusion. Besides that, buccolingual inclination showed statistically significant relapse in nonextraction treatments (Table IV). Buccolingual inclination is related to torque control in posterior segments. Some studies show high scores for this criterion evidencing the deficiency in placing adequate torque in the buccal segments.[27,34] Furthermore, some authors[20,46] also found that buccolingual inclination tends to deteriorate over time with the natural aging process. This could have contributed to the higher relapse in the nonextraction cases.

It could be observed that some occlusal characteristics improved at the long-term. Marginal ridges significantly improved over the years in both nonextraction and extraction treatments (Table IV). Additionally, occlusal and interproximal contacts significantly improved at the long-term in extraction cases. Marginal ridges and occlusal contacts are related to the settling of the occlusion after treatment, according to previous studies.[25,31,32,34] Besides that, this improvement also could be justified by the occlusal tooth wear, which is a physiologic consequence of aging.[20,47] Interproximal contacts evaluate if interproximal spaces were totally closed with treatment, mainly in extraction cases. This improvement occurred because great part of the extraction cases was treated in the 1970’s, and in that time, bands were still placed in all teeth, leaving several interproximal spaces when appliance was removed. Over the years, these generalized spaces closed. This improvement seems to have contributed to the slight increase of the OGS score in the extraction group at T3.

Marginal ridges and buccolingual inclination showed significant lower scores in the extraction group at T2 (Table V). This is in agreement with Farhadian et al.[26], where the final occlusion of patients treated with extraction seemed more acceptable than nonextraction. At T3, only the buccolingual inclination and root angulation showed

significantly higher scores in the nonextraction group (Table V). Fleming et al.[24] did not even evaluate this component in their nonextraction treatments. Despite significant, difference was only 1.32 between the two groups, and this could be considered not significant clinically.

The nonextraction group showed significantly greater relapse according to the OGS score (Table VI). Despite marginal ridges had better improvement in nonextraction treatments from T2 to T3, their occlusal relationship and interproximal contacts worsened more in long-term, which contributed to the greater relapse in this group. Bhupali et al[29] found no difference in the relapse regarding OGS scores between nonextraction and extraction treatments, however, their postretention observation period was only 3 years.

These results demonstrate that some parameters of a completed case remain stable over time, but others do not. Therefore, it is important to know if these changes are similar with natural aging in treated and untreated patients.[38,48,49] A study of aging of normal occlusion using OGS scores reported that the aging process slightly deteriorates some occlusal features of individuals with normal occlusion, and, interestingly also found that most of them were satisfied with their smiles even at the sixth decade of life.[20]

Patients of both groups were equally highly satisfied with the outcomes and their smile, and subjects in the nonextraction group perceived more the worsening in their teeth alignment than the extraction group (Table VII). These long-term results are in agreement with Miranda et al.[20], but their subjects had normal untreated occlusions. Al-Omiri et al.[50] reported different results; patients treated nonextraction showed lesser satisfaction. There are several factors that are related to patient satisfaction.[50,51] Studies show that long-term patient satisfaction is slightly associated with the stability of the orthodontic treatment regardless of the initial occlusal condition or the final result of the orthodontic treatment.[51] However, according to Keles and Bos[52] the doctor-patient relationship remains the most important factor contributing to patient satisfaction. This statement confirms the feedback that we received from patients in T3, where the great majority reported being very well attended by the orthodontic graduate students at the University Clinic, and also having great memories related to that. So, this must be the mainly reason why we found great patient satisfaction (more than 75% in both groups), even in deteriorated occlusion, irrespective of treatment type. Furthermore, it is important to highlight that this questionnaire was not previously validated and the above speculations should be regarded with caution.

Clinical implications

With increasing life expectancy, orthodontists expect that the results of their orthodontic treatments remain stable for many years. With the findings of this study, orthodontists can be aware of which occlusal trait will be improved or deteriorated over time in each treatment protocol, as well to recognize where are the most common flaws at finishing, improve the relationship between doctor-patient and then provide high level orthodontic treatment. It will also be possible to explain to the patient the changes that may occur in their occlusion along many years' posttreatment, irrespective of the type of treatment.

CONCLUSIONS

- PAR index improved with treatment and PAR and OGS indexes showed significant increase indicating significant occlusal relapse at the long-term in both groups.
- Alignment, buccolingual inclination and occlusal relationship worsened over time, while marginal ridges, occlusal and interproximal contacts improved at long-term stage.
- The nonextraction group showed more occlusal relapse than the extraction group regarding OGS Index, but patient satisfaction was similar in both groups.
- In the nonextraction group, patients perceived more changes in alignment over time than in the extraction group.

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List of the legends to the figures

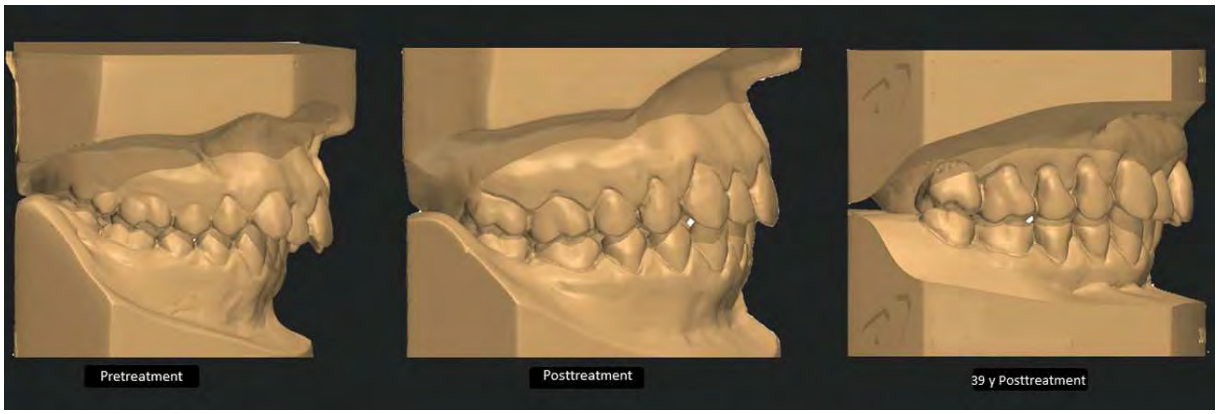

Figure 1

Figure 2

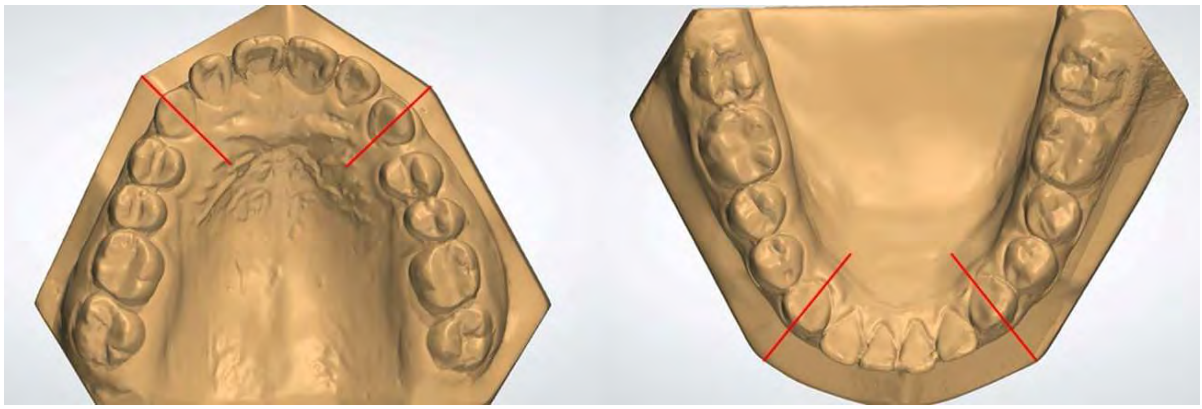

Figure 3


VERTICAL
0 None
1 openb 2t > 2mm
CENTRELINE
0 < = 1/4
1 1/4 - 1/2
2 > 1/2
OVERBITE
0 0 - 1/3
1 1/3 - 2/3
2 > 2/3
3 > = FTC
4
openb
CONTACT Pt
0 –
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PAR INDEX
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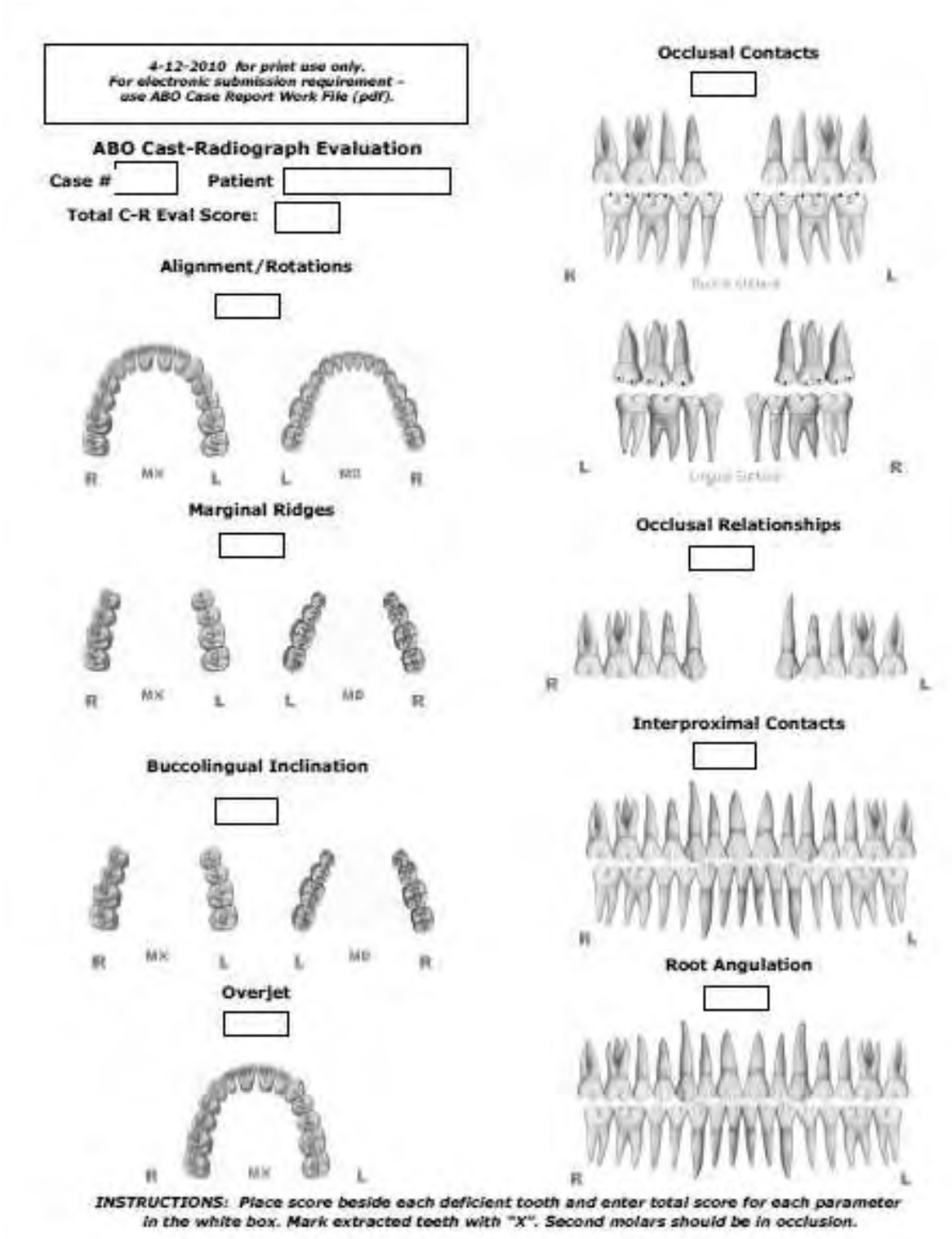
Figure 4

Figure 5


4-12-2010 for print use only.
For electronic submission requirement –
use ABO Case Report Work File (pdf).
ABO Cast-Radiograph Evaluation
Case #
Patient
Total C-R Eval Score:
Alignment/Rotations
Marginal Ridges
Buccolingual Inclination
Overjet
Occlusal Contacts
Occlusal Relationships
Interproximal Contacts
Root Angulation
R
MX
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INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter
in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

Figure 6

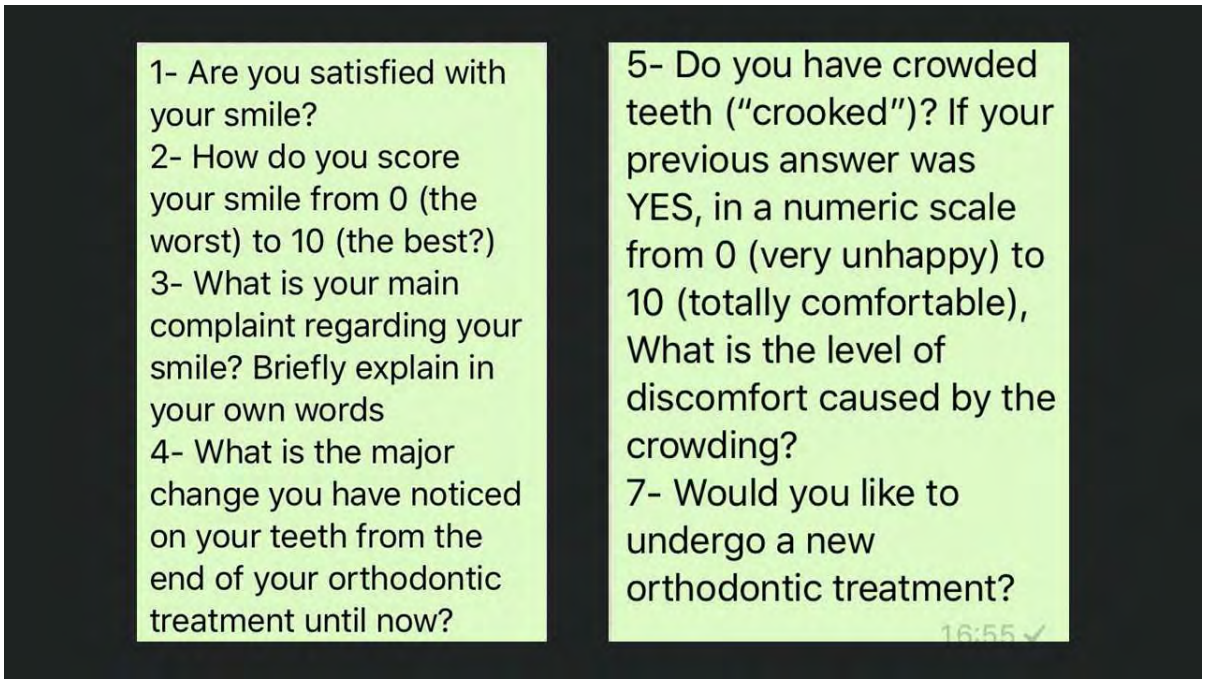
1- Are you satisfied with your smile?
2- How do you score your smile from 0 (the worst) to 10 (the best?)
3- What is your main complaint regarding your smile? Briefly explain in your own words
4- What is the major change you have noticed on your teeth from the end of your orthodontic treatment until now?
5- Do you have crowded teeth ("crooked")? If your previous answer was YES, in a numeric scale from 0 (very unhappy) to 10 (totally comfortable), What is the level of discomfort caused by the crowding?
7- Would you like to undergo a new orthodontic treatment?
16:55

Figure 7

Table I. Results of the error study (Dahlberg's formula for casual errors and dependent t tests for systematic errors).

Variables	1st Measurement (N=32)		2nd Measurement (N=32)		Dahlberg	P
	Mean	**s.d.**	**Mean**	**s.d.**		
PAR	12.18	11.44	12.53	11.72	1.17	0.244
OGS	42.40	17.97	42.65	17.81	1.83	0.593

Table II. Results of intergroup comparability of the ages and treatment time, long-term follow up evaluation and retention times (independent t tests), sex distribution and type of malocclusion (chi-square tests).

Variables	GROUP 1 NONEXTRACTION (N=16)		GROUP 2 EXTRACTION (N=41)		P
	Mean	SD	Mean	SD	
Age T1 (y)	13.20	0.82	13.31	1.97	0.841 £
Age T2 (y)	15.070	1.16	15.63	2.14	0.322 £
Age T3(y)	50.32	6.05	53.60	5.51	0.054 £
Treatment Time (y)	1.86	0.82	2.32	0.59	**0.022*** £
Long-term follow-up time (y)	35.25	6.11	37.96	4.54	0.071 £
Retention time (y)	2.26	1.17	2.26	1.26	0.983 £
Sex					X^2 =0.004
Males	6		15		DF= 1
Females	10		26		P=0.948 ¥
Type malocclus.					X^2 =1.592
Class I	6		23		DF= 1
Class II	10		18		P=0.206 ¥

* Statistically significant at P<0.05.
£ independent t test
¥ chi-square test

Table III. Results of the intragroup comparison of the PAR index among the initial, final and long-term posttreatment stages of the Nonextraction and Extraction groups separately (repeated measures ANOVA and Tukey tests).

Variables	T1	T2	T3	P
	Mean (SD)	Mean (SD)	Mean (SD)	
NONEXTRACTION GROUP (N=16)				
PAR	25.75 (9.76) ^{A}	2.81 (2.42) ^{B}	8.62 (9.76) ^{C}	**0.000***
EXTRACTION GROUP (N=41)				
PAR	23.75 (8.46) ^{A}	3.14 (1.98) ^{B}	7.56 (4.35) ^{C}	**0.000***

* Statistically significant at P<0.05.
Different letters in a row indicate the presence of a statistically significant difference between the groups.

Table IV. Results of the intragroup comparison of OGS index and components between the final and long-term posttreatment stages of the Nonextraction and Extraction group separately (dependent t tests).

Variables	T2 - FINAL		T3 – LONG-TERM		P
	Mean	SD	Mean	SD	
NONEXTRACTION GROUP (N=16)					
OGS	31.81	9.46	41.00	19.36	**0.012***
Alignment	5.87	2.68	10.37	4.41	**0.000***
Marginal ridges	5.62	1.74	1.81	1.10	**0.000***
Buccolingual Inclination	6.93	4.26	9.87	4.37	**0.024***
Overjet	3.75	2.35	5.81	4.47	0.121
Occlusal contacts	3.68	3.40	2.56	3.74	0.272
Occlusal relationship	0.87	1.89	4.50	6.42	**0.014***
Interproximal contacts	0.87	1.36	1.25	2.23	0.587
Root Angulation	4.18	2.13	4.81	2.00	0.222
EXTRACTION GROUP (N=41)					
OGS	31.14	5.68	33.82	10.06	**0.045***
Alignment	5.68	2.89	10.63	4.00	**0.000***
Marginal ridges	4.34	1.55	2.10	1.59	**0.000***
Buccolingual inclination	4.43	2.75	5.22	2.90	0.140
Overjet	4.29	2.57	5.34	4.33	0.111
Occlusal contacts	4.80	2.78	3.44	3.19	**0.014***
Occlusal relationship	1.82	1.75	2.83	3.24	**0.047***
Interproximal contacts	2.14	2.52	0.78	1.70	**0.001***
Root Angulation	3.60	1.80	3.49	1.80	0.698

* Statistically significant at P<0.05.

Table V. Results of intergroup comparison of initial (T1), final (T2) and long-term posttreatment stages (T3)(independent t tests).

Variables	GROUP 1 NONEXTRACTION (N=16)		GROUP 2 EXTRACTION (N=41)		P
	Mean	SD	Mean	SD	
T1 - Initial					
PAR	25.75	9.76	23.75	8.46	0.447
T2 - Final					
Indexes					
PAR	2.81	2.42	3.14	1.98	0.594
OGS	31.81	9.46	31.14	5.68	0.745
OGS components					
Alignment	5.87	2.68	5.68	2.89	0.819
Marginal ridges	5.62	1.74	4.34	1.55	**0.009***
Buccolingual Inclination	6.93	4.26	4.43	2.75	**0.011***
Overjet	3.75	2.35	4.29	2.57	0.467
Occlusal contacts	3.68	3.40	4.80	2.78	0.206
Occlusal relationship	0.87	1.89	1.82	1.75	0.077
Interproximal contacts	0.87	1.36	2.14	2.52	0.062
Root Angulation	4.18	2.13	3.60	1.80	0.306
T3 - Long-term posttreatment					
Indexes					
PAR	8.62	9.76	7.56	4.35	0.447
OGS	41.00	19.36	33.82	10.06	0.072
OGS components					
Alignment	10.37	4.41	10.63	4.00	0.831
Marginal ridges	1.81	1.10	2.10	1.59	0.515
Buccolingual Inclination	9.87	4.37	5.22	2.90	**0.000***
Overjet	5.81	4.47	5.34	4.33	0.715
Occlusal contacts	2.56	3.74	3.44	3.19	0.378
Occlusal relationship	4.50	6.42	2.83	3.24	0.197
Interproximal contacts	1.25	2.23	0.78	1.70	0.395
Root Angulation	4.81	2.00	3.49	1.80	**0.019***

* Statistically significant at P<0.05.

Table VI. Results of intergroup comparison of treatment changes (T2-T1) and long-term posttreatment changes (T3-T2)(independent t tests).

Variables	**GROUP 1 NONEXTRACTION (N=16)**		**GROUP 2 EXTRACTION (N=41)**		**P**
	Mean	**SD**	**Mean**	**SD**	
T2-T1 – Treatment Changes					
PAR	-22.93	9.58	-20.60	8.49	0.373
T3-T2 – Long-term Posttreatment Changes					
Indexes					
PAR	5.81	7.00	4.41	4.20	0.358
OGS	9.18	12.96	2.68	8.30	**0.028***
OGS components					
Alignment	4.50	3.91	4.95	4.34	0.718
Marginal ridges	-3.81	1.97	-2.24	2.29	**0.019***
Buccolingual Inclination	2.93	4.69	0.78	3.32	0.055
Overjet	2.06	5.02	1.05	4.12	0.436
Occlusal contacts	-1.12	3.94	-1.37	3.43	0.820
Occlusal relationship	3.62	5.23	1.00	3.13	**0.023***
Interproximal contacts	0.37	2.70	-1.37	2.57	**0.027***
Root Angulation	0.62	1.96	-0.12	2.00	0.208

* Statistically significant at P<0.05.

Table VII. Results of intergroup comparison of the answers to the patient's satisfaction questionnaire.

Variables	GROUP 1 NONEXTRACTION (N=13)	GROUP 2 EXTRACTION (N=28)	P
Satisfaction **Yes** **No**	 76.92% (10) 23.08% (3)	 82.15% (23) 17.85% (5)	X^2 =0.15 DF= 1 P=0.694 ¥
Smile score	8.38 (1.70)	8.35 (1.68)	0.961 £
Main complain	None: 46.15% (6) Bruxism: 23.7% (3) Alignment (Spacing/crowding) 23.7% (3) Color: 7.69% (1) Others: 0% (0)	None: 60.71% (17) Bruxism: 0% (0) Alignment (Spacing/crowding) 21.42% (6) Color 10.71% (3) Others: 7.16% (2)	X^2 =7.81 DF= 4 P=0.098 ¥
Perceived changes over time	Alignment: 46.15% (6) None: 38.46 (5) Tooth wear: 15.38% (2)	Alignment: 25% (7) None: 75% (21) Tooth wear: 0% (0)	X^2 =7.81 DF= 2 P=**0.024*** ¥
Do you have crowded teeth	No: 53.16% (7) Yes: 46.15% (6)	No :53.58% (15) Yes: 46.42% (13)	X^2 =0.00 DF= 1 P=0.986 ¥
Discomfort caused by the crowding (0-Unhappy to 10-no discomfort)	6.50 (3.78)	6.30 (2.89)	0.904 £
Would you be willing to undergo a new orthodontic treatment	If necessary: 69.23% (9) No: 15.38% (2) Retreating: 15.38% (2)	If necessary: 64.28% (18) No: 32.14% (9) Retreating: 3.57% (1)	X^2 =2.65 DF= 2 P=0.265 ¥

* Statistically significant at P<0.05.
£ independent t test
¥ chi-square test

3 DISCUSSION

3 DISCUSSION

This is a retrospective study with the long-term evaluation time of almost 40 years posttreatment (mean of 35 years postretention), and is the longest described in the orthodontic literature that we know until now. Most of the similar studies have focused on comparing the nonextraction and premolar extraction techniques with shorter follow-up periods.(Al Yami; Kuijpers-Jagtman; van 't Hof, 1999; Erdinc; Nanda; Isiksal, 2006; Freitas et al., 2017; Holman et al., 1998; Luppanapornlarp; Johnston, 1993; Paquette; Beattie; Johnston, 1992) Limited information exists on the evaluation of the 2 treatment approaches using the ABO OGS index.(Anthopoulou; Konstantonis; Makou, 2014; Bhupali et al., 2019; Deguchi et al., 2005 Since life expectancy is increasing,{Foreman, 2018 #207; Farhadian; Miresmaeili; Soltani, 2005; Mislik et al., 2016; Yang-Powers et al., 2002) it is important for the orthodontists to be aware of the occlusal changes that patients may present over posttreatment time. It must be noted that retrospective studies are necessary as they can give reasonable, ethical and long-term data that can later be used as inclusion/exclusion criteria in RCTs.(Bjering et al., 2017) Furthermore, an RCT with a follow-up period of 40 years can be difficult to conduct.

Although the sample is small in the nonextraction group, it is substantial, because the subjects were evaluated more than 35 years after postretention. According to Otuyemi and Jones,(Otuyemi; Jones, 1995a) there are several reasons besides the long-term follow up that lead to a low response rate to recall, as lack of incentive to take time off from work, patients who were happy with the treatment outcome and had fairly stable results, and those that had substantial relapse and possibly retreated.

In this study, in order to evaluate crowding and dental arch dimensions relapse, digital dental casts were used and the measurements were performed with a digital software. Three-dimensional dental casts' measurement has been an optimal alternative to plaster dental casts with excellent agreement.(Soto-Alvarez et al., 2020; Sousa et al., 2012)

The groups were comparable regarding several parameters that could influence comparisons: type of malocclusion, ages at all stages, long-term follow up evaluation and retention times, sex distribution and type of malocclusion. This manner, achieved orthodontic treatment results could be evaluated with increased reliability. Treatment time was statistically significant longer in the extraction group than in the nonextraction group, a mean of 4 to 5 months longer, similar to a previous study' results.(Bishara; Cummins; Zaher, 1997) It was expected, since it is known that orthodontic treatment performed with premolar extraction are longer than those nonextraction.(Vig et al., 1990) But some points must be highlighted: the duration of treatment also depends on patient cooperation, treatment objectives, techniques and dentist expertise. The extraction decision is merely one of the clinical variables.(Vig et al., 1990)

This study showed that maxillary and mandibular arches tended to become more crowded postretention. Maxillary crowding at T1 was considered severe (8.54mm)(Little, 1975) in the nonextraction group. At T2, anterior crowding was corrected with treatment and had minimal irregularity for both arches; both maxillary and mandibular incisors presented significant relapse from T2 to T3; however, maxillary crowding relapsed only 36.04%, while mandibular crowding relapsed 84.47% of the correction, returning close to pretreatment values. These results are similar to some studies.(Canuto et al., 2013; Freitas et al., 2004; Sadowsky et al., 1994) However, Sadowsky et al.(Sadowsky et al., 1994) found different results at T3, that were greater in our study. They found a mean irregularity of 2 and 2.4mm to the maxillary and mandibular arch respectively, and the present study found 3.98mm in the maxillary and 3.78mm in the mandibular arch. This difference could be related to the prolonged retention time in their study (8.4 years) and also due to a long-term follow up observation period in ours. Freitas et al.(Freitas et al., 2004) also found even smaller results for mandibular irregularity at T3, but their postretention follow up was up only 5 years.

The extraction group showed greater amount of anterior crowding for mandibular and maxillary arches at T1, both considered as severe by Little.(Little, 1975) At T2, anterior crowding was corrected with treatment and presented significant relapse at T3, with minimum to moderate irregularity (3.71mm for maxillary and 4.56mm for mandibular arch), but not returning close to baseline values . These results are in agreement with the current orthodontic literature.(Freitas et al., 2017; Little;

Wallen; Riedel, 1981) Little's studies(Little, 1990; Little; Riedel; Artun, 1988; Little; Riedel; Engst, 1990; Little; Wallen; Riedel, 1981) indicate that anterior crowding is a continuous phenomenon into the 20-40 ages and likely beyond.

Our results support previous studies that show a significant increase in anterior crowding and a significant reduction in arch dimensions after long-term follow up.(Artun; Garol; Little, 1996; Bishara; Cummins; Zaher, 1997; Sadowsky; Sakols, 1982) At pretreatment (T1), mandibular anterior crowding was significantly greater in extraction group than in nonextraction. Another studies showed similar results.(Artun; Garol; Little, 1996; Erdinc; Nanda; Isiksal, 2006; Paquette; Beattie; Johnston, 1992) This shows that the extraction decision may be related to the amount of tooth discrepancy present at pretreatment.

Maxillary and mandibular arch length were longer in nonextraction group at T1. Artun et al.(Artun; Garol; Little, 1996) reported similar results. At posttreatment (T2), maxillary intercanine width was significantly greater in the extraction group, similar to previous studies.(Bishara; Cummins; Zaher, 1997; Luppanapornlarp; Johnston, 1993) This is due to distal movement of the canine during the retraction to solve crowding. However, Gardner and Chaconas(Gardner; Chaconas, 1976) reported significant increase in mandibular intercanine width for both nonextraction and extraction groups and Erdinc et al.(Erdinc; Nanda; Isiksal, 2006) found that this increase was significant in nonextraction patients. All others maxillary and mandibular dental arch dimensions were significantly reduced in the extraction group both at T2 and T3. This results is supported by other authors.(Paquette; Beattie; Johnston, 1992; Rossouw; Preston; Lombard, 1999; Shapiro, 1974) Differently, some authors(Artun; Garol; Little, 1996; Kahl-Nieke; Fischbach; Schwarze, 1995) found that extraction cases were more crowded at T3, probably due to individual sample variations and could be related to arch form.

Mandibular irregularity index showed greater correction in the extraction group than in nonextraction group. This was expected, since the amount of initial mandibular crowding was greater in the extraction group. Furthermore, as a result of treatment with premolar extractions, interpremolar and intermolar widths, as well as arch length and arch perimeter showed greater reduction in the extraction group than in nonextraction group. It is obvious, because treatment that involves extractions had

their arch length during treatment generally decreased. Finally, extraction and nonextraction groups showed similar amount of relapse of anterior crowding.(Bishara; Cummins; Zaher, 1997; Uhde; Sadowsky; BeGole, 1983)

The amount of initial maxillary anterior crowding was similar in both groups (8.84mm in nonextraction cases and 9.67mm in extraction group) and the relapse percentage was also similar in the groups (36.04% in the nonextraction group and 29.13% in the extraction group). However, in the mandibular arch, the extraction cases had greater crowding than nonextraction cases at pretreatment (8.82mm and 4.27mm, respectively), showed similar amount of relapse (3.43mm in extraction cases and 2.61 in nonextraction group), but significantly lower percentage of relapse in the extraction than in the nonextraction group (44.66% and 84.46%, respectively). It highlights the unpredictable character of the anterior crowding relapse. This is in accordance with previous reports.(Dyer; Vaden; Harris, 2012; Erdinc; Nanda; Isiksal, 2006) Artun et al.(Artun; Garol; Little, 1996) reported similar results for mandibular irregularity, despite the amount of crowding in our sample was higher at T1. Luppanapornlarp et al.(Luppanapornlarp; Johnston, 1993) also found similar results, with no statistically difference in the relapse in both groups, but the relapse rate at T3 in the nonextraction group exceed their baseline values. and the irregularity index at T3 was higher than their baseline values, however this study only evaluate Class II borderline patients.(Luppanapornlarp; Johnston, 1993) However, Kahl-Nieke et al.(Kahl-Nieke; Fischbach; Schwarze, 1995) found greater relapse of maxillary anterior crowding in the extraction group than the nonextraction and some authors(Luppanapornlarp; Johnston, 1993; Paquette; Beattie; Johnston, 1992) rely that both nonextraction and extraction treatment show an essentially identical pattern of posttreatment relapse/settling that are related more to the differential growth of the jaws than to the posttreatment position and orientation of the denture.

Arch dimension changes were similar for both groups in the long-term, except for the mandibular arch perimeter, that showed more decrease in the extraction group. Although not significant, mandibular anterior crowding relapse was greater in the extraction group, and this justifies the greater decrease in the mandibular arch.

When evaluating the orthodontic treatment outcomes and stability, it is necessary to determine the changes from pretreatment to posttreatment stages, as

well as to match the malocclusion severity at the beginning. The OGS system,(Casko et al., 1998) although highly sensitive to determine occlusal traits, scores only the treatment results. So, to ensure great reliability, the PAR index(DeGuzman et al., 1995; Richmond et al., 1992b) was also used, to quantify the malocclusion severity and the improvement with treatment.

Overall, nonextraction and extraction groups showed similar treatment results (T2-T1) and relapse (T3-T2) according to PAR index. This was previous demonstrated.(Freitas et al., 2013) The relapse rates of 25.33% and 21.45% in nonextraction and extraction groups were very similar, whereas the OGS scores showed greater relapse in nonextraction treatment. At T3, nonextraction group had a mean OGS score of 41.00 while the extraction group had a mean of 33.82, very close to the passing score. So, it is possible to conclude that the PAR index is not very sensitive and does not assess minor discrepancies in tooth positions, but it is superior for evaluating therapeutic improvement from T1 to T2.(Deguchi et al., 2005) Additionally, ABO-OGS measures individual teeth based on the deviation distance (mm), while PAR analyses segment units, based on definitions like: “one-quarter to one half lower incisor width”.(Hong et al., 2014) Due to this, treatment changes from posttreatment to postretention will be discussed below according to the OGS index.

Nonextraction and extraction treatments had OGS scores close to the ABO passing scores (30), indicating good finishing. Alignment and occlusal relationship significantly worsened in both groups at T3. Alignment relapse was previously demonstrated.(Aszkler et al., 2014; Nett; Huang, 2005) The studies found that this was the only criterion with less predictable change.(Little, 1990; Struble; Huang, 2010) It could be speculated that the relapse of occlusal relationship in the nonextraction group is due to the presence, although not significant, of more Class II than Class I patients. Correction of Class II malocclusion in nonextraction patients can be accounted by cervical headgear and intermaxillary Class II elastics and are quite stable over the years.(Elms; Buschang; Alexander, 1996; Janson et al., 2013) However, in this study the long follow-up time may have been partially responsible for this relapse. In the extraction cases, this minimum relapse could be due to the anchorage loss, buccal inclination of the maxillary and lingual inclination of the mandibular incisors that are evident in long-term extraction cases, caused by the effects of “en masse” retraction.(Geron et al., 2003) Yang-Powers et al.(Yang-Powers et al., 2002) and

Aszkler et al.(Aszkler et al., 2014) stated that overjet often improves with time. On the other hand, Uhde et al.(Uhde; Sadowsky; BeGole, 1983) found that posttreatment changes in overjet were unrelated to the type of malocclusion. Besides that, buccolingual inclination showed statistically significant relapse in nonextraction treatments. Buccolingual inclination is related to torque control in posterior segments. Some studies show high scores for this criteria evidencing the deficiency in placing adequate torque in the buccal segments.(Anthopoulou; Konstantonis; Makou, 2014; Knierim; Roberts; Hartsfield, 2006) Furthermore, some authors(Greco et al., 2010; Miranda et al., 2019) also found that buccolingual inclination tends to deteriorate over time with the natural aging process. This could have contributed to the higher relapse in the nonextraction cases.

It could be observed that some occlusal characteristics improved at the long-term. Marginal ridges significantly improved over the years in both nonextraction and extraction treatments. Additionally, occlusal and interproximal contacts significantly improved at the long-term in extraction cases. Marginal ridges and occlusal contacts are related to the settling of the occlusion after treatment, according to previous studies.(Aszkler et al., 2014; Knierim; Roberts; Hartsfield, 2006; Nett; Huang, 2005; Yang-Powers et al., 2002) Besides that, this improvement also could be justified by the occlusal tooth wear, which is a physiologic consequence of aging.(Kim; Kho; Lee, 2000; Miranda et al., 2019) Interproximal contacts evaluate if interproximal spaces were totally closed with treatment, mainly in extraction cases. This improvement occurred because great part of the extraction cases was treated in the 1970's, and in that time, bands were still placed in all teeth, leaving several interproximal spaces when appliance was removed. Over the years, these generalized spaces closed. This improvement seems to have contributed to the slight increase of the OGS score in the extraction group at T3.

These results demonstrate that some parameters of a completed case remain stable over time, but others do not. Therefore, it is important to know if these changes are similar with natural aging in treated and untreated patients.(Freitas et al., 2013; Jonsson et al., 2010; Massaro et al., 2018) There are several studies reporting this maturational changes,(Freitas et al., 2013; Jonsson; Magnusson, 2010; Massaro et al., 2018; Richardson, 1999; Rinchuse et al., 2014; Sinclair; Little, 1983) indicating a decrease in arch length and perimeter and an increase in anterior alignment.

Abdulraheem et al.(Abdulraheem; Schutz-Fransson; Bjerklin, 2020) stated that as about 25% of the displaced incisors can be considered as an effect of natural growth, not a relapse of the orthodontic treatment. The majority claim that the changes found in a sample of untreated normal were similar in nature but lesser in extent than postretention changes found in a sample of treated cases.(Freitas et al., 2013; Glenn; Sinclair; Alexander, 1987; Sinclair; Little, 1983) A study of aging of normal occlusion using OGS scores reported that the aging process slightly deteriorates some occlusal features of individuals with normal occlusion, and, interestingly also found that most of them were satisfied with their smiles even at the sixth decade of life.(Miranda et al., 2019)

Patients of both groups were equally highly satisfied with the outcomes and their smile, and subjects in the nonextraction group perceived more the worsening in their teeth alignment than the extraction group. These long-term results are in agreement with Miranda et al.(Miranda et al., 2019), but their subjects had normal untreated occlusions. Al-Omiri et al.(Al-Omiri; Abu Alhaija, 2006) reported different results; patients treated nonextraction showed lesser satisfaction. There are several factors that are related to patient satisfaction.(Al-Omiri; Abu Alhaija, 2006; Maia et al., 2010) Studies show that long-term patient satisfaction is slightly associated with the stability of the orthodontic treatment regardless of the initial occlusal condition or the final result of the orthodontic treatment.(Maia et al., 2010) However, according to Keles and Bos(Keles; Bos, 2013) the doctor-patient relationship remains the most important factor contributing to patient satisfaction. This statement confirms the feedback that we received from patients in T3, where the great majority reported being very well attended by the orthodontic graduate students at the University Clinic, and also having great memories related to that. So, this must be the mainly reason why we found great patient satisfaction (more than 75% in both groups), even in deteriorated occlusion, irrespective of treatment type.

LIMITATIONS

This is a retrospective study, and one can say that they have a low level of evidence, but it must be noted that retrospective studies are necessary as they can give reasonable, ethical and long-term data that can later be used as

inclusion/exclusion criteria in RCTs. Furthermore, an RCT with a follow-up period of 40 years can be difficult to conduct.

The sample size in the nonextraction group: Although the sample is small in the nonextraction group, it is substantial, because the subjects were evaluated more than 35 years after postretention.

4 FINAL CONSIDERATIONS

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There was no difference in the amount of relapse of anterior crowding in cases treated with and without premolar extraction in long-term. The percentage of maxillary anterior crowding relapse was similar in both groups; 36.04% for the nonextraction group and 29.13% in the extraction group. However, the percentage of relapse of mandibular anterior crowding was higher in the nonextraction (84.46%) than in the extraction group (44.66%). There was no difference in the long-term relapse of transversal arch dimensions in cases treated with and without extractions. Mandibular arch perimeter showed more decrease in the long-term in extraction cases.

PAR index improved with treatment and PAR and OGS indexes showed significant increase at the long-term in both groups. Alignment, buccolingual inclination and occlusal relationship worsened over time, while marginal ridges, occlusal and interproximal contacts improved at long-term stage. The nonextraction group showed more occlusal relapse than the extraction group regarding OGS Index, but patient satisfaction was similar in both groups.

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APPENDIXES

APPENDIXES

APPENDIX A – Declaration of exclusive use of the article 1 in thesis.

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We hereby declare that we are aware of the article "Long-term comparison of anterior crowding and dental arch dimensions relapse in cases treated with and without extractions" will be included in thesis of the graduate student Paula Patricia Cotrin da Silva and may not be used in other works of Graduate Programs at the Bauru Dental School, University of São Paulo.

Bauru, February 28th of 2020.

Paula Patricia Cotrin da Silva

Karina Maria Salvatore de Freitas

Marcos Roberto de Freitas

APPENDIX B - Declaration of exclusive use of the article 2 in thesis.

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Bauru, February 28th of 2020.

Paula Patrícia Cotrin da Silva

Karina Maria Salvatore de Freitas

Marcos Roberto de Freitas

ANNEXES

ANNEXES

ANNEX A – Research Institutional Board approval, protocol number 71629217.5.0000.5417.

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PARECER CONSUBSTANCIADO DO CEP

DADOS DA EMENDA

Título da Pesquisa: Comparação da recidiva oclusal em casos com e sem extrações de pré-molares em longo prazo.

Pesquisador: PAULA PATRICIA COTRIN DA SILVA

Área Temática:

Versão: 3

CAAE: 71629217.5.0000.5417

Instituição Proponente: Universidade de Sao Paulo

Patrocinador Principal: Financiamento Proprio

DADOS DO PARECER

Número do Parecer: 3.834.763

Apresentação do Projeto:

Os pesquisadores apresentam uma emenda da pesquisa para:

1 - alteração do título

2 - aumentar a amostra, sem alteração da metodologia.

Objetivo da Pesquisa:

Apresentação da emenda da pesquisa.

Avaliação dos Riscos e Benefícios:

não se aplica.

Comentários e Considerações sobre a Pesquisa:

O item 1-Mudança do título do projeto que passará a se intitular: "Comparação da recidiva oclusal de casos com e sem extrações de pré-molares em longo prazo".

O item 2-Inclusão de 17 indivíduos a mais na amostra do que o planejado no projeto.

Na busca pelos pacientes não foi possível encontrar pacientes portando contenção fixa inferior após 15 anos de tratamento, e tendo em vista a disponibilidade de pacientes já tratados com ou sem extrações, decidimos por comparar a recidiva oclusal entre os 2 grupos, sem alteração da metodologia. Como a busca resultou em mais pacientes dispostos a participar, aumentamos o número de participantes, e mais uma vez salientando que não houve alteração na metodologia, e

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sim apenas no que avaliamos. Refiero que, assim como descrito no projeto, os dados destes 17 indivíduos também foram conseguidos de maneira retrospectiva nos arquivos de documentação da disciplina de Ortodontia FOB-USP, respeitando-se o sigilo dos nomes e dados pessoais dos pacientes em todos as etapas da pesquisa.

O n final será de 57 indivíduos com má oclusão inicial de Classe I ou Classe II de Angle, que foram previamente tratados ortodonticamente, com ou sem extrações. Todos os pacientes da amostra serão leucodermas.

Considerações sobre os Termos de apresentação obrigatória:
Idem acima

Conclusões ou Pendências e Lista de Inadequações:
Aprovado.

Considerações Finais a critério do CEP:
A emenda apresentada pelo(a) pesquisador(a) foi considerada APROVADA na reunião ordinária do CEP de 05/02/2020, com base nas normas éticas da Resolução CNS 466/12. Ao término da pesquisa o CEP-FOB/USP exige a apresentação de relatório final. Os relatórios parciais deverão estar de acordo com o cronograma e/ou parecer emitido pelo CEP. Alterações na metodologia, título, inclusão ou exclusão de autores, cronograma e qualsquer outras mudanças que sejam significativas deverão ser previamente comunicadas a este CEP sob risco de não aprovação do relatório final. Quando da apresentação deste, deverão ser incluídos todos os TCLEs e/ou termos de doação assinados e rubricados, se pertinentes.

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Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_1499276_E1.pdf	17/01/2020 14:11:48		Aceito
Folha de Rosto	folhaderosto_emenda.pdf	17/01/2020 14:10:48	PAULA PATRICIA COTRIN DA SILVA	Aceito
Outros	Carta_de_Encaminhamento_Emenda_Paula.doc	17/01/2020 14:08:37	PAULA PATRICIA COTRIN DA SILVA	Aceito
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Aprovado

Necessita Apreciação da CONEP:
Não

BAURU, 12 de Fevereiro de 2020

Assinado por:
Ana Lúcia Pompéia Fraga de Almeida
(Coordenador(a))

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ANNEX B – Guidelines for AJO-DO submissions: Original Article

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AUTHOR INFORMATION PACK

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Systematic Review and Meta-Analysis Guide for Authors

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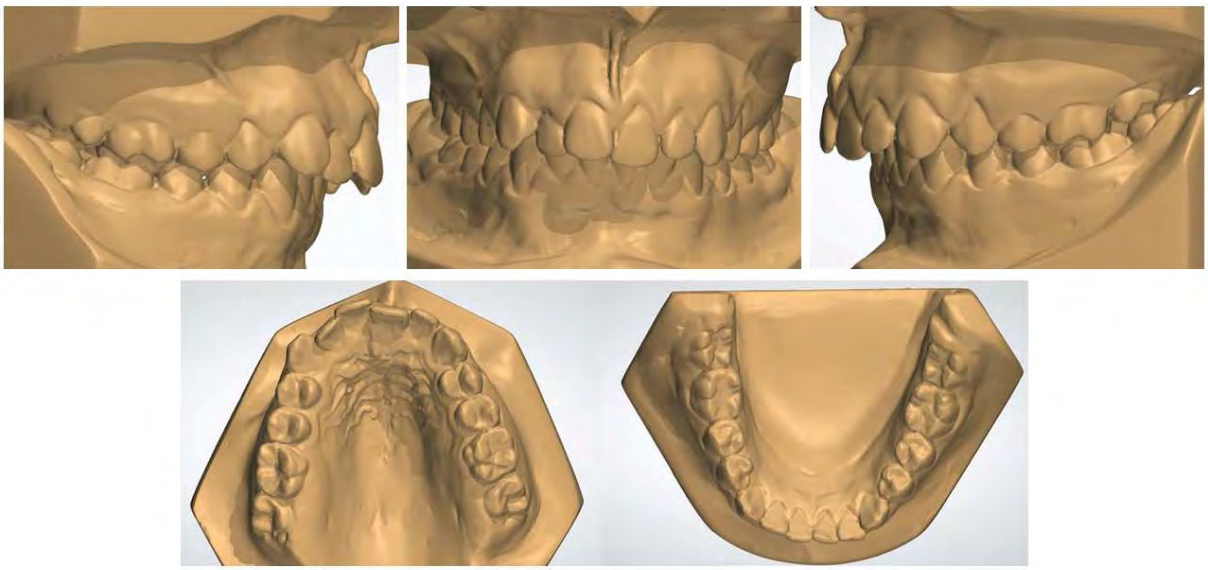
ANNEX C – Nonextraction patient at pretreatment, posttreatment and 40 years follow up



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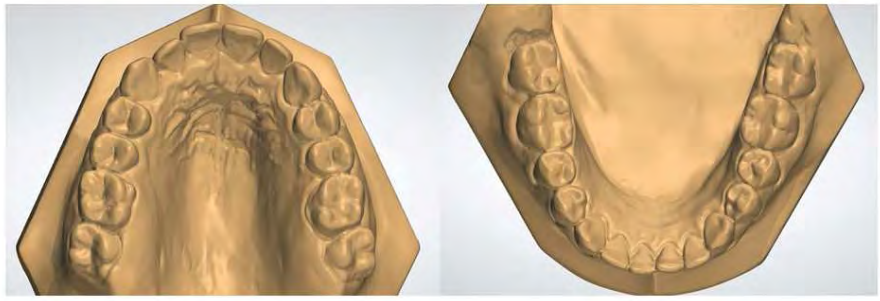
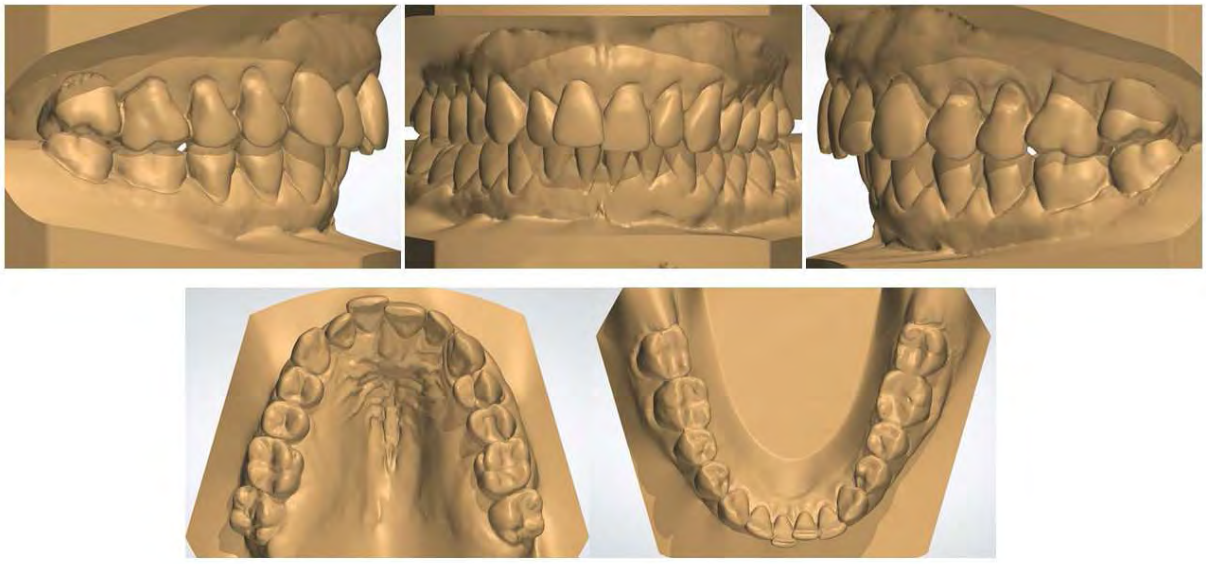


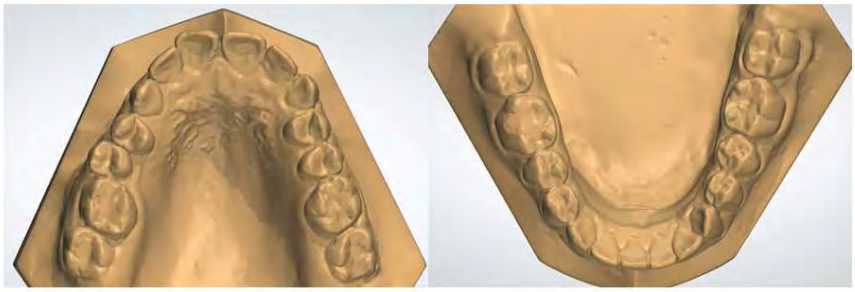
Posttreatment



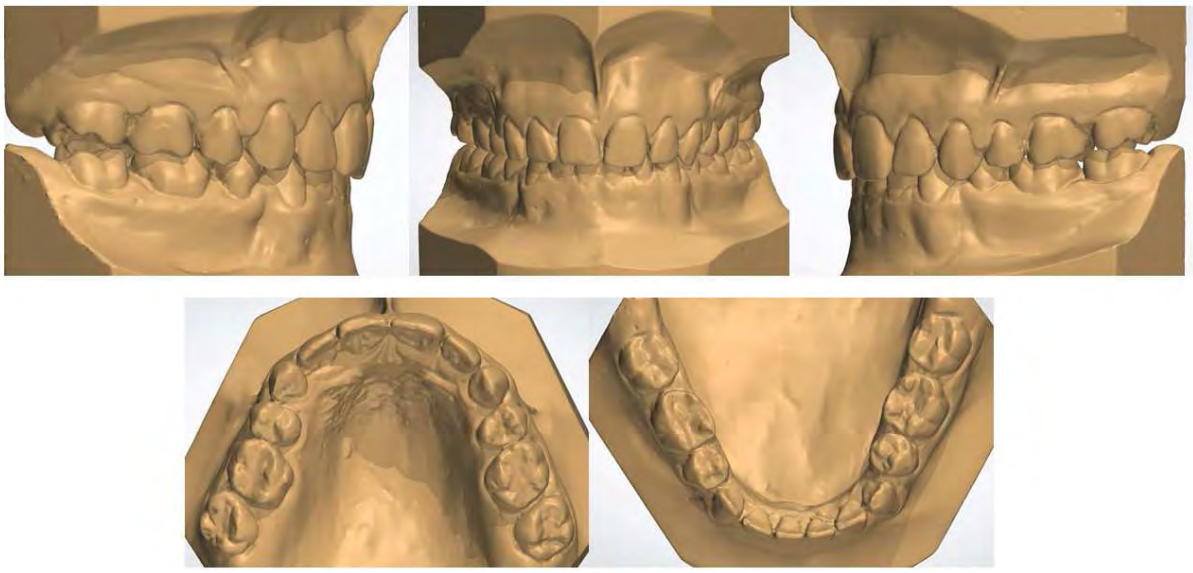
40 years follow up

40 years follow up

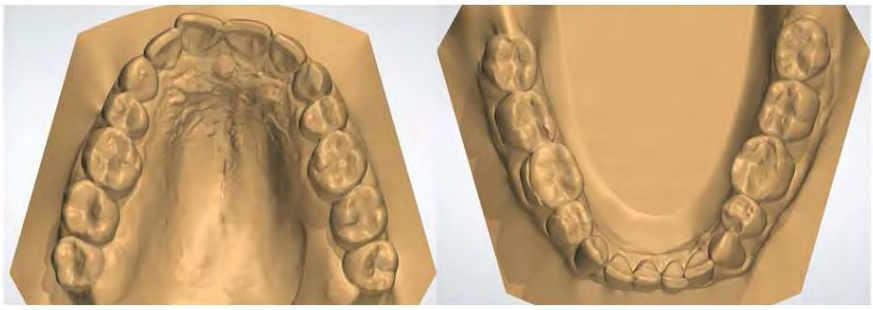
ANNEX D – Extraction patient at pretreatment, posttreatment and 43 years follow up



Pretreatment



Posttreatment



43 years follow up

43 years follow up