UNIVERSIDADE FEDERAL DO PARANÁ

FÁBIO MARZULLO ZARONI

ROTAÇÃO DO PLANO OCLUSAL EM CIRURGIA ORTOGNÁTICA E A INFLUÊNCIA NAS ARTICULAÇÕES TEMPOROMANDIBULARES E NO VOLUME DA VIA AÉREA SUPERIOR

CURITIBA

2023

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Tese apresentada ao Programa de Pós-graduação em Odontologia, Setor de Ciências da Saúde, da Universidade Federal do Paraná, como requisito parcial à obtenção do título de Doutor em Odontologia.

Orientadora: Profa. Dra. Rafaela Scariot
Coorientador: Prof. Dr. José Vinicius Bolognesi Maciel

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PROGRAMA DE PÓS-GRADUAÇÃO ODONTOLOGIA -
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Os membros da Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação ODONTOLOGIA da Universidade Federal do Paraná foram convocados para realizar a arguição da tese de Doutorado de **FÁBIO MARZULLO ZARONI** intitulada: **ROTAÇÃO DO PLANO OCLUSAL EM CIRURGIA ORTOGNÁTICA E A INFLUÊNCIA NAS ARTICULAÇÕES TEMPOROMANDIBULARES E NO VOLUME DA VIA AÉREA SUPERIOR** , sob orientação da Profa. Dra. RAFAELA SCARIOT, que após terem inquirido o aluno e realizada a avaliação do trabalho, são de parecer pela sua APROVAÇÃO no rito de defesa.
A outorga do título de doutor está sujeita à homologação pelo colegiado, ao atendimento de todas as indicações e correções solicitadas pela banca e ao pleno atendimento das demandas regimentais do Programa de Pós-Graduação.

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ATA Nº226

ATA DE SESSÃO PÚBLICA DE DEFESA DE DOUTORADO PARA A OBTENÇÃO DO GRAU DE DOUTOR EM ODONTOLOGIA

No dia dezoito de dezembro de dois mil e vinte e tres às 08:30 horas, na sala DEFESA ON LINE - PLATAFORMA TEAMS, CAMPUS BOTÂNICO, foram instaladas as atividades pertinentes ao rito de defesa de tese do doutorando **FÁBIO MARZULLO ZARONI**, intitulada**: ROTAÇÃO DO PLANO OCLUSAL EM CIRURGIA ORTOGNÁTICA E A INFLUÊNCIA NAS ARTICULAÇÕES TEMPOROMANDIBULARES E NO VOLUME DA VIA AÉREA SUPERIOR** , sob orientação da Profa. Dra. RAFAELA SCARIOT. A Banca Examinadora, designada pelo Colegiado do Programa de Pós-Graduação ODONTOLOGIA da Universidade Federal do Paraná, foi constituída pelos seguintes Membros: RAFAELA SCARIOT (UNIVERSIDADE FEDERAL DO PARANÁ), ALEXANDRE MORO (null), LEANDRO EDUARDO KLÜPPEL (UNIVERSIDADE FEDERAL DO PARANÁ), DELSON JOÃO DA COSTA (UNIVERSIDADE FEDERAL DO PARANÁ), SILVIA AMÉLIA SCUDELER VEDOVELLO (CENTRO UNIVERSITÁRIO HERMINIO OMETTO). A presidência iniciou os ritos definidos pelo Colegiado do Programa e, após exarados os pareceres dos membros do comitê examinador e da respectiva contra argumentação, ocorreu a leitura do parecer final da banca examinadora, que decidiu pela APROVAÇÃO. Este resultado deverá ser homologado pelo Colegiado do programa, mediante o atendimento de todas as indicações e correções solicitadas pela banca dentro dos prazos regimentais definidos pelo programa. A outorga de título de doutor está condicionada ao atendimento de todos os requisitos e prazos determinados no regimento do Programa de Pós-Graduação. Nada mais havendo a tratar a presidência deu por encerrada a sessão, da qual eu, RAFAELA SCARIOT, lavrei a presente ata, que vai assinada por mim e pelos demais membros da Comissão Examinadora.

CURITIBA, 18 de Dezembro de 2023.

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Avaliador Externo (CENTRO UNIVERSITÁRIO HERMINIO OMETTO)

RESUMO

Introdução: cirurgia ortognática (CO) e disfunção temporomandibular (DTM) podem estar intimamente ligados. Estudos demonstram que o procedimento cirúrgico possa melhorar ou piorar sinais e sintomas de DTM. Além disso, as cabeças da mandíbula podem sofrer remodelação ou alteração de volume em resposta ao reposicionamento dos ossos. A CO pode causar também modificação na dimensão e volume da via aérea superior. Além do mais, envolve frequentemente, alterações na angulação do plano oclusal, uma variável que até o momento não foi avaliada para possível relação com sinais e sintomas de DTM, volume de cabeças da mandíbula e volume de via aérea superior. **Objetivos**: analisar se o sentido e magnitude da modificação da angulação do plano oclusal em pacientes submetidos cirurgia ortognática tem influência nos sinais e sintomas de DTM, no volume das cabeças da mandíbula e de via aérea superior. **Materiais e métodos**: trata-se de uma pesquisa observacional, longitudinal, prospectiva onde foram coletados dados nos períodos pré-operatório e pós-operatório de 7 dias e de 6 meses. Todos os participantes foram indivíduos a serem submetidos a tratamento com cirurgia ortognática no Departamento de Cirurgia e Traumatologia Buco-Maxilo-Facial da Universidade Federal do Paraná. Para serem incluídos no estudo, os participantes deveriam ter 18 anos de idade ou mais, com total autonomia para tomar decisões, concordar em participar do estudo e assinar o Termo de Consentimento Livre e Esclarecido (TCLE). O projeto foi aprovado por Comitê de Ética em Pesquisa de acordo com a Declaração de Helsinque. Foram coletados dados de sinais e sintomas de disfunção temporomandibular utilizando a ferramenta DC/TMD. Imagens de tomografia computadorizada de feixe cônico (TCFC) de todos os períodos foram utilizadas para mensuração da angulação do plano oclusal, volume das cabeças da mandíbula e da via aérea superior. Os exames de imagem foram realizados no tomógrafo i-CAT Cone Beam 3D Imaging System (3D Imaging System, Imaging Sciences International Inc., Hatfield, PA, EUA) com um campo de visão FOV de 16 x 13 cm, uma resolução de 0,25 mm, 37,07 mAs, 120 kVp e tempo de exposição de 26,9 segundos. Foi utilizado *software* gratuito e de código aberto ITK-SNAP (http://www.itksnap.org) para mensurações. As mensurações foram realizadas por um único pesquisador, devidamente treinado por um especialista (padrão ouro) e calibrado. Foi adotado o nível de significância de 95% ($p<0.05$). As análises descritivas e inferenciais foram realizadas com o uso do software IBM® SPSS 20.0 (Statistical Package for Social Sciences, EUA). **Resultados**: Após a utilização dos critérios de exclusão e computadas as perdas de seguimento, a amostra final resultou em 50 participantes, 27 mulheres (54%) e 23 homens (46%). A idade média foi de 29,5 anos (min. 18 - máx. 52). As deformidades esqueléticas encontradas foram: duas classe I (4%); dezenove classe II (38%) e vinte e nove classe III (58%). Foram 24 rotações do plano oclusal no sentido anti-horário (48%) e 26 no sentido horário (52%). As rotações menores (0 a 2 graus) foram 25 (50%) e as maiores (acima de 2 graus) foram 25 (50%). Alguns dos sinais e sintomas de DTM melhoraram ($p<0,05$), mas não foram relacionados com o sentido e magnitude da rotação do plano oclusal ($p>0,05$) para todas as variáveis DC/TMD investigadas. Mudanças no volume dos côndilos mandibulares não foram associadas com o sentido e magnitude da rotação do plano oclusal ($p>0,05$). Houve um aumento significativo no volume da orofaringe nos pacientes classe II ($p=0.026$) e no volume da nasofaringe nos pacientes classe III ($p=0.003$). Embora não tenha havido diferença significativa entre a quantidade de movimento anteroposterior para os diferentes sentidos de rotação do plano oclusal nos pacientes classe II e III, encontramos resultados significativos que demonstraram aumento do volume da nasofaringe tanto na rotação do plano oclusal no sentido horário (p=0.035) quanto no sentido anti-horário (p=0.037) nos pacientes classe III. **Conclusões**: Embora tenha havido melhorias significativas nos sinais e sintomas de DTM, estas não foram correlacionadas com o sentido e magnitude da rotação do plano oclusal ocasionada pela cirurgia ortognática. O sentido e a magnitude da rotação do plano oclusal ocasionada pela cirurgia ortognática não se correlacionaram com as alterações no volume das cabeças da mandíbula. Os pacientes classe II apresentaram um aumento significativo no volume da orofaringe e os classe III no volume da nasofaringe entre os períodos pré-operatório e pós-operatório. Foi encontrada uma correlação significativa entre o sentido de rotação do plano oclusal e as alterações no volume da nasofaringe em pacientes classe III. Não houve correlação entre o sentido da rotação do plano oclusal e as alterações no volume da via aérea superior nos pacientes classe II.

Palavras-chave: cirurgia ortognática; plano oclusal; disfunção temporomandibular; cabeça da mandíbula; via aérea superior.

ABSTRACT

Introduction: Orthognathic surgery (OS) and temporomandibular dysfunction (TMD) may be closely linked. Studies show that the surgical procedure can improve or worsen signs and symptoms of TMD. In addition, the mandibular condyles may undergo remodeling and volume changes in response to the repositioning of the bones. CO can also cause changes in the size and volume of the upper airway. OS often involves changes in the angulation of the occlusal plane, a variable that, to date, has not been evaluated for a possible relationship with TMD signs and symptoms, mandibular head volume, and upper airway volume. Objectives: To analyze whether the direction and magnitude of the change in occlusal plane angulation in patients undergoing orthognathic surgery influences TMD signs and symptoms, mandibular condyles volume, and upper airway volume. Materials and methods: This is an observational, longitudinal, prospective study in which data was collected in the preoperative and postoperative periods of 7 days and six months. All participants were individuals undergoing treatment with orthognathic surgery at the Department of Oral and Maxillofacial Surgery and Traumatology at the Federal University of Paraná. To be included in the study, participants had to be 18 or older, have full autonomy to make decisions, agree to participate, and sign the Free, Prior, and Informed Consent Form (FPIC). The Research Ethics Committee approved the project in accordance with the Declaration of Helsinki. Data on signs and symptoms of temporomandibular dysfunction were collected using the DC/TMD tool. Cone beam computed tomography (CBCT) images from all periods were used to measure occlusal plane angulation, mandibular condyles volume, and upper airway volume. The imaging exams were carried out on the i-CAT Cone Beam 3D Imaging System (3D Imaging System, Imaging Sciences International Inc., Hatfield, PA, USA) with a FOV field of view of 16 x 13 cm, a resolution of 0.25 mm, 37.07 mAs, 120 kVp and an exposure time of 26.9 seconds. Free, open-source ITK-SNAP software (http://www.itksnap.org) was used for measurements. A single researcher carried out the measurements, was adequately trained by a specialist (gold standard), and calibrated. A significance level of 95% ($p<0.05$) was adopted. Descriptive and inferential analyses were performed using IBM® SPSS 20.0 software (Statistical Package for Social Sciences, USA). Results: After using the exclusion criteria and computing the follow-up losses, the final sample consisted of 50 participants: 27 women (54%) and 23 men (46%). The average age was 29.5 years (min. 18 - max. 52). The skeletal deformities found were two class I (4%), nineteen class II (38%), and twenty-nine class III (58%). There were 24 counterclockwise rotations of the occlusal plane (48%) and 26 clockwise rotations (52%). There were 25 minor rotations (0 to 2 degrees) and 25 major rotations (over 2 degrees). Some of the signs and symptoms of TMD improved ($p<0.05$). However, they were not related to the direction and magnitude of rotation of the occlusal plane ($p>0.05$) for all DC/TMD variables investigated. Changes in the volume of the mandibular condyles were not associated with the direction and magnitude of occlusal plane rotation ($p>0.05$). There was a significant increase in the volume of the oropharynx in class II patients ($p=0.026$) and the volume of the nasopharynx in class III patients ($p=0.003$). Although there was no significant difference between the amount of anteroposterior movement for the different directions of rotation of the occlusal plane in class II and III patients, we found significant results showing increased nasopharynx volume in both clockwise ($p=0.035$) and counterclockwise ($p=0.037$) rotations of the occlusal plane in class III patients. Conclusions: Although there were significant improvements in the signs and symptoms of TMD, these were not correlated with the direction and magnitude of occlusal plane rotation caused by orthognathic surgery. The direction and magnitude of occlusal plane rotation caused by orthognathic surgery did not correlate with changes in mandibular head volume. Class II patients showed a significant increase in oropharyngeal volume, and class III patients in nasopharyngeal volume between the preoperative and postoperative periods. A significant correlation was found between the direction of rotation of the occlusal plane and changes in nasopharyngeal volume in class III patients. There was no correlation between the direction of rotation of the occlusal plane and changes in the upper airway volume in class II patients.

Keywords: orthognathic surgery; occlusal plan; temporomandibular disorder; mandibular condyle; upper airway.

LISTA DE ABREVIATURAS

PO – Plano Oclusal

MAA – Mordida Aberta Anterior

MCA – Mordida Cruzada Anterior

DTM – Disfunção Temporomandibular

ATM – Articulação Temporomandibular

OSBRM – Osteotomia Sagital Bilateral dos Ramos Mandibulares

VAS – Via Aérea Superior

AOS – Apneia Obstrutiva do Sono

ENA – Espinha Nasal Anterior

ENP – Espinha Nasal Posterior

SUMÁRIO

1 INTRODUÇÃO

1.1 Deformidade dentofacial e classificação

A deformidade dentofacial é um termo que descreve a condição em que o crescimento e desenvolvimento do esqueleto facial foge à normalidade. De interesse da odontologia, os ossos afetados são a maxila e mandíbula, podendo também afetar as suas estruturas adjacentes (Fish *et al.*, 1993). A forma e tamanhos alterados destes ossos podem afetar a estrutura e a função da região oral e a estética facial. Em se tratando da região oral, a deformidade dentofacial está frequentemente associada a uma má-oclusão, ou seja, uma relação desarmônica entre arcada dentária superior e inferior. Na estética facial, podem repercutir no perfil facial, onde os perfis de face mais comuns são os convexos e côncavos, encontrados principalmente em deformidades dentofaciais tipo classe II e III respectivamente. Além disso, em visão frontal do rosto, devido a crescimentos anormais dos ossos maxilares no sentido transversal e vertical, uma deformidade dentofacial pode causar assimetrias e desarmonia de proporção entre os terços faciais (Fish *et al.*, 1993). Assimetrias ocorrem normalmente por diferenças no tamanho, forma ou posição dos ossos do lado esquerdo e direito do rosto.

A deformidade dentofacial é comumente classificada com base na relação dos maxilares. Prognatismo é o termo dado à projeção ou crescimento anterior excessivo de um dos maxilares. Retrognatismo por outro lado ocorre quando um ou ambos os maxilares é subdesenvolvido ou posicionado mais para posterior. A deformidade dentofacial tipo classe II acontecem quando existe uma relação mais distal da arcada inferior em relação à superior e pode acontecer quando há isoladamente retrognatismo mandibular ou prognatismo maxilar, além de, uma combinação entre retrognatismo mandibular e prognatismo maxilar. No caso da deformidade tipo classe III existe uma relação mais anterior da arcada inferior (com ou sem mordida cruzada anterior). Pode acontecer por retrognatismo maxilar ou prognatismo mandibular isoladamente ou combinação de retrognatismo maxilar e prognatismo mandibular. Nas deformidades do tipo classe I, as arcadas dentárias estão corretamente relacionadas, podendo existir desalinhamentos dentários ou presença e diastemas (espaços entre dentes), porém os ossos maxilares terem tamanhos desproporcionais (Gateno *et al*., 2015).

As deformidades dentofaciais podem ser de origem congênita ou adquirida, sendo causadas por síndromes que afetam o crescimento e desenvolvimento dos ossos da face, hábitos deletérios que podem começar durante a infância e por traumas envolvendo a face (Obwegeser, 2007).

O tratamento dessas deformidades dentofaciais moderadas a severas muitas vezes envolve uma combinação de ortodontia e cirurgia ortognática. O plano de tratamento é geralmente personalizado para cada paciente, e depende do tipo e da gravidade da deformidade. O tratamento pode melhorar significativamente a função mastigatória, a fala e a aparência facial do paciente, além de ter um impacto positivo em sua qualidade de vida e bem-estar psicossocial (Eslamipour *et al.*, 2017).

1.2 Cirurgia ortognática

A cirurgia ortognática abrange todo um conjunto de técnicas cirúrgicas utilizadas para corrigir deformidades dentofaciais (da Silva*, et al.,* 2018). Uma das técnicas mais utilizadas para este fim é a osteotomia sagital bilateral dos ramos mandibulares (OSBRM) estabelecida por Obwegeser e Trauner em 1955. Sofreu algumas modificações ao longo do tempo, sendo as principais as feitas por Dal Pont em 1961 e Epker em 1977. Ela é a técnica cirúrgica mais utilizada para correção de deformidades da mandíbula pois permite o seu reposicionamento em vários sentidos. As suas indicações principais incluem a correção do excesso ou deficiência ântero-posterior de mandíbula e assimetrias (Orloff e Hale, 2007; Ozdemir *et al.*, 2009; Monson, 2013; Herford *et al.*, 2014). Outra técnica comumente utilizada é a osteotomia Le Fort I. É caracterizada por uma secção horizontal, da abertura piriforme ao processo pterigoide da maxila bilateralmente, foi primeiramente descrita por Langebeck, em 1861, e consolidada biologicamente como acesso cirúrgico seguro com base nos estudos de microcirculação óssea, publicados por Bell em 1975. Por meio dela é possível a realização de movimentos no sentido transversal, sagital e vertical da maxila (Bauer e Ochs, 2014). Adicionalmente é possível realizar segmentação da maxila para realização de movimentos em dois ou mais sentidos, em diferentes regiões do osso, no mesmo procedimento cirúrgico (Kahnberg e Hagberg, 2007).

1.3 Plano oclusal e Cirurgia Ortognática

Downs foi o primeiro a fazer referência ao plano oclusal numa análise cefalométrica. Definiu o plano oclusal como tangente às pontas das cúspides dos molares e pré-molares, passando pelas bordas incisais dos incisivos centrais. O plano oclusal deve intersectar a região anterior no ponto médio do trespasse vertical dos incisivos, separarando a porcão coronária dos dentes superiores e inferiores de maneira igual. Também sugeriu uma definição modificada do plano oclusal nos casos em que os incisivos se apresentem em infraoclusão ou supraoclusão. Nestes casos, o plano é identificado através dos pontos de contato dos molares e pré-molares desconsiderando os dentes anteriores (Downs, 1949). Este pode ser denominado de plano oclusal funcional e é mais efetivo na avaliação de pacientes com deformidades dentofaciais que possuam má-oclusão grave, curva de *Spee* acentuada e mordidas abertas (Reyneke, 1998).

A relação angular do plano oclusal (PO) no sentido sagital se dá com o plano horizontal de Frankfurt (plano que passa pelas margens superiores dos meatos acústicos externos e pelas margens inferiores das órbitas). Os valores referenciais deste ângulo é de 8° ± 4°, para adultos (Reyneke e Evans, 1990; Reyneke, 1998; Reyneke, 1999).

Existem dois tipos faciais que podem ser mais favorecidos pela modificação do ângulo do PO em cirurgia ortognática: o tipo braquicefálico, com o ângulo do PO menor que 4° e o tipo dolicocefálico, onde o PO apresenta angulação maior que 12° (Reyneke e Evans, 1990).

Algumas das características clínicas e radiográficas básicas do tipo facial braquicefálico com angulação diminuída do PO incluem: ângulo do plano mandibular diminuído; ângulos goníacos proeminentes; projeção do mento em relação ao alvéolo mandibular; curva de *Spee* acentuada; e trespasse vertical acentuado (Reyneke, 1998) Já no tipo facial dolicocefálico com angulação aumentada do PO normalmente o ângulo do plano mandibular é aumentado. Pode existir tanto o excesso vertical anterior da maxila e/ou mandíbula, como a diminuição da altura vertical posterior da maxila e/ou mandíbula e a projeção do mento pode ser diminuída em relação ao osso alveolar na região anterior. Além disso, no sentido sagital, a deficiência anteroposterior da mandíbula é bastante comum (Reyneke, 1999; Wolford *et al.*, 1993).

As modificações angulares do PO podem ser planejadas para ocorrer no sentido horário e anti-horário (Reyneke e Evans, 1990). Pacientes com tipo facial braquicefálico e ângulo do PO diminuído podem ter indicação para cirurgia ortognática com rotação do ângulo do PO no sentido horário. As modificações anatômicas e cefalométricas que ocorrem após este tipo de procedimento cirúrgico são: aumento do ângulo do PO, aumento do ângulo do plano mandibular com consequente aumento da altura facial ântero-inferior (Wolford *et al.*, 1994). Já os pacientes com tipo facial dolicocefálico, quando indicada, a correção cirúrgica poderá levar à rotação do PO no sentido anti-horário. Como consequência, teremos a diminuição do ângulo do PO, diminuição do ângulo do plano mandibular e da altura facial ântero-inferior (Wolford *et al.*, 1993).

Em cirurgias combinadas de maxila e mandíbula, o plano oclusal é determinado pela autorrotação da mandíbula. Neste caso, a maxila é levada para uma posição mais favorável através de rotação sobre pontos de referência na região anterior da face e a mandíbula é então ajustada para assegurar uma oclusão dentária mais próxima do ideal (Reyneke e Evans, 1990).

A alteração do plano oclusal está intimamente ligada com a melhora na estética facial e também deve ser levada em conta no planejamento para buscar maior estabilidade dos casos (Reyneke e Evans, 1990). A alteração mais dramática e deliberada da angulação do PO ocorre normalmente na correção de deformidades dentofaciais com assimetrias faciais e é uma consequência inevitável da qualquer ajuste da posição vertical da maxila e rotação resultante da mandíbula (Reyneke e Evans, 1990).

A manipulação do PO em cirurgia ortognática pode ser definida como a rotação da maxila e mandíbula para se obter melhores resultados estéticos e funcionais. (Reyneke, 1998). Esta alteração do plano oclusal não deve ser arbitrária e depende da correta seleção, durante o planejamento cirúrgico, do melhor ponto de referência cefalométrico para rotação da maxila. Os pontos podem estar localizados entre a espinha nasal posterior (ENP) e espinha nasal anterior (ENA). Além disso, a maxila pode ser rotacionada tendo como referência um ponto na incisal dos incisivos centrais superiores. A rotação da maxila ao redor do ponto escolhido poderá causar aumento ou diminuição do ângulo do PO e a sua escolha deve ser ditada pela necessidade estética de cada caso, uma vez que mudanças diferentes são esperadas, dependendo da posição do ponto escolhido (Reyneke e Evans, 1990; Reyneke, 1998). As modificações esperadas podem ser: alteração do ângulo do plano mandibular, alteração na exposição do incisivo superiores, modificação da altura facial anteroinferior, alteração angulação dos incisivos superiores e/ou inferiores e modificação da projeção do mento (Reyneke, 1998).

1.4 Disfunção Temporomandibular (DTM) e Cirurgia Ortognática

A cirurgia ortognática promove modificações substanciais na posição dos ossos do terço médio e inferior da face. Devido a extensa manipulação óssea e muscular, após a cirurgia, tensões e pressões diferentes podem afetar as articulações temporomandibulares (ATM). Por isto, e principalmente quando se almeja o reposicionamento da mandíbula, é importante que antes do procedimento cirúrgico, seja observada a anatomia das ATM, bem como a presença de sinais e sintomas de disfunção temporomandibular. Qualquer evidência de patologia deve ser cuidadosamente avaliada e se possível, tratada. Pacientes com condições artríticas ou processos reabsortivos podem exigir tratamento especial, incluindo a consideração de cirurgia simultânea da ATM ou como procedimento separado antes de cirurgia ortognática (Wolford *et al*., 1993). Em casos mais graves o procedimento de cirurgia ortognática pode ser até contra-indicado. A influência da cirurgia ortognática nos sintomas da DTM é um assunto controverso, uma vez que ainda não existe prova concreta de causalidade entre eles na literatura, além disso, as DTM se apresentam com causas multifatoriais o que pode gerar fatores de confundimento em pesquisas científicas. Existem publicações que demonstram tanto correlação positiva como negativa entre cirurgia ortognática e disfunção temporomandibular, ou seja, pode haver melhora, mas também possibilidade de desenvolvimento de sintomas em pacientes que não apresentavam DTM antes da cirurgia (Sebastiani *et al.*, 2016).

1.5 Volume das cabeças da mandíbula e Cirurgia Ortognática

Variações de dimensão das cabeças da mandíbula podem ser uma característica individual, podem ocorrer após uma cirurgia ortognática ou trauma e até serem idiopáticas. Podem acontecer como remodelação e/ou reabsorção. A remodelação da cabeça da mandíbula representa um diagnóstico mais comum e é na maioria das vezes caracterizada pela preservação da altura do ramo mandibular (Hoppenreijs *et al*., 1998; Kobayashi *et al*., 2012). Não há alteração dimensional significante mas a sua forma pode mudar. Está relacionada a um processo fisiológico ósseo adaptativo à uma nova carga funcional imposta às articulações temporomandibulares. Por outro lado, a reabsorção, além de mais rara, normalmente está associada a um processo clinicamente mais grave com repercussão estética e funcional (Wolford *et al*., 1993; An *et al.*, 2014; Krisjane *et al.*, 2015).

1.6 Volume da via aérea superior e Cirurgia Ortognática

O reposicionamento do(s) osso(s), resultante da cirurgia ortognática pode modificar o volume da via aérea superior (VAS), inclusive podendo alterar o fluxo de ar para os pulmões. O fluxo de ar normal pode estar diretamente relacionado com uma respiração adequada e boa qualidade do sono. Por outro lado, a diminuição do fluxo de ar ou obstrução da VAS pode causar a apnéia obstrutiva do sono (AOS) (Brevi *et al.*, 2011; Mattos *et al.*, 2011; de Souza Carvalho *et al.*, 2012). Existem diferenças nas repercussões dos tipos de cirurgia ortognática no volume da via aérea superior, e isto depende, do sentido e a quantidade de movimento dos ossos, podendo haver aumento ou diminuição de sua dimensão, com impacto variável no fluxo de ar (Raffaini e Pisani, 2013; Choi *et al.*, 2015; Shin *et al.*, 2015; Hart *et al.*, 2015; Hatab *et al.*, 2015; Parsi *et al.*, 2019). Nas últimas décadas, a tomografia computadorizada e a reconstrução volumétrica tem sido uma ferramenta de pesquisa importante para avaliação da modificação no volume da via aérea superior em consequência do reposicionamento ósseo causado pela cirurgia ortognática. Embora muitas metodologias tenham sido publicadas e pesquisas continuem surgindo, percebe-se que a evolução das técnicas e tecnologias de diagnóstico por imagem, tem levado a resultados de mensuração progressivamente mais fidedignos (Mattos *et al.*, 2011; Raffaini e Pisani, 2013; Hatab *et al.*, 2015; Chang *et al.*,2017).

2 OBJETIVOS

2.1 Objetivo do Artigo 1

Analisar se a modificação da angulação do plano oclusal em pacientes submetidos cirurgia ortognática tem influência nos sinais e sintomas de disfunção temporomandibular e no volume das cabeças da mandíbula.

2.2 Objetivo do Artigo 2

Analisar se a modificação da angulação do plano oclusal em pacientes submetidos cirurgia ortognática tem influência no volume da via aérea superior.

3 ARTIGO 1

Title: What is the influence of sagittal occlusal plane rotation in orthognathic surgery on temporomandibular joint?

Abstract

Objective: this study focused on the question of whether the magnitude and direction of the occlusal plane rotation in patients undergoing orthognathic surgery influences the signs and symptoms of temporomandibular joint disorders (TMD) and the volume of the mandibular condyles.

Materials and methods: this is an observational, longitudinal, prospective study in which data was collected in the preoperative and postoperative periods of 7 days and 6 months. All participants were individuals undergoing treatment with orthognathic surgery. To be included in the study, participants had to be 18 years of age or older, with full autonomy to make decisions, agree to take part in the study and sign the Free, Prior and Informed Consent Form (FPIC). The project was approved by the Research Ethics Committee in accordance with the Declaration of Helsinki. Data on signs and symptoms of temporomandibular dysfunction were collected preoperatively and 6 months after surgery, using the DC/TMD tool. Cone beam computed tomography (CBCT) images from all periods were used to measure occlusal plane angulation and mandibular condyles volume. The measurements were carried out by a single researcher, properly trained by a specialist (gold standard) and calibrated. A significance level of 95% ($p<0.05$) was adopted for statistical purpose.

Results: Data from 50 participants were evaluated 27 women (54%) and 23 men (46%). The median age was 29.5 years (min. 18 - max. 52). Skeletal deformity found was two class I (4%); nineteen class II (38%) and twenty-nine class III (58%). There were 24 counterclockwise (48%) and 26 clockwise (52%) rotations of the occlusal plane. Minor rotations (0 to 2 degrees) were 25 (50%) and major (above 2 degrees) were 25 (50%). Some of the signs and symptoms of TMD improved ($p<0.05$) but were not related to the direction and magnitude of rotation of the occlusal plane ($p>0.05$) for all DC/TMD variables investigated. Changes in the volume of the mandibular condyles were not associated with the direction and magnitude of occlusal plane rotation ($p>0.05$).

Conclusion(s): Although there was improvement in TMD signs and symptoms, this was not correlated with the direction and magnitude of occlusal plane rotation. The direction and magnitude of occlusal plane rotation did not correlate with changes in the mandibular condyles volume.

Introduction

Dentofacial deformities are a group of congenital or acquired conditions that affect the structure and function of the oral and facial regions. They may result from the interaction between hereditary and environmental factors.[1] These deformities can involve the maxilla, mandible, teeth, and associated soft tissues, resulting in aesthetic and functional issues. Treatment for dentofacial deformities often involves a combination of orthodontics and orthognathic surgery.[2] Orthognathic surgery can reposition the jaws to improve facial balance and function, and the treatment plan will vary depending on the type and severity of the deformity.[3]

Orthognathic surgery often involves alterations to the occlusal plane.[4-6] The occlusal plane is tangent to the tips of the cusps of the upper and lower molars and premolars, passing through the incisal edges of the incisors when the teeth are in contact (maximum intercuspation). In both traditional and 3D cephalometry[7], the occlusal plane line must pass in the anterior region through the midpoint of the vertical overlap of the incisors; that is, the line must separate the coronal portion of the upper and lower teeth equally. In the case of anterior open bite or crossbite, the anterior point must be at the average distance between the incisal edges of the incisor's teeth. The measurement of the angulations of the occlusal plane uses the Frankfurt plane as a reference. When planning orthognathic surgery, the surgeon may consider the angle of the occlusal plane and its relationship to other facial structures for aesthetic and functional outcomes. Altering the occlusal plane can help improve the patient's occlusion and enhance facial aesthetics.

Orthognathic surgery and temporomandibular joint (TMJ) disorders seem interconnected in several ways.[10,11] TMJ disorders encompass a range of problems associated with the temporomandibular joint, the hinge connecting the mandible to the skull, and the muscles responsible for jaw movement. These disorders can cause pain, difficulty moving the mandible, and other symptoms. By correcting the position of the maxilla and mandible, orthognathic surgery can help relieve the TMJ stress and improve its function. However, there is also a risk that TMJ symptoms can develop or worsen after orthognathic surgery.[12]

Besides, changes and repositioning of the mandible in orthognathic surgery can indirectly impact the condyles due to the alteration of forces and pressures within the TMJ.[12] The mandibular condyles can undergo adaptive remodeling in response to changes in the mechanical environment.[13] The new positioning of the mandible can lead to changes in how forces are distributed across the joint, potentially causing the condyles to remodel slowly over time, which may affect their volume.[14] In some cases, there is a risk of condylar resorption after orthognathic surgery, where the mandibular condyles begin to reabsorb or diminish in volume way faster.[15] This can be due to a variety of factors, including changes in the biomechanical environment of the joint, systemic factors, hormonal influences, and genetic predispositions.[16]

Based on this information and the lack of literature about this subject, the objective of this research was to analyze whether the change in the angulation of the occlusal plane in patients undergoing orthognathic surgery influences the signs and symptoms of temporomandibular dysfunction and the volume of the condyles of the mandible during follow-up.

We expect to answer the question if the magnitude and/or direction of rotation of the occlusal plane in orthognathic surgery, whether planned or not, is a factor that oral and maxillofacial surgeons should consider when planning their cases.

The research hypothesis is that signs and symptoms of temporomandibular dysfunction and volume of the mandibular condyles, should be altered by the modifications in the occlusal plane angulation caused by orthognathic surgery.

Materials and methods

Ethics

The project was approved by the Research Ethics Committee of the Health Sciences Sector at UFPR according to the Declaration of Helsinki.

Individuals were invited to participate in the study receive information regarding the research verbally. Those who agree to participate sign the Free, Prior and Informed Consent Form (FPIC), which explained the objectives and justifications for carrying out the study, as well as the benefits and risks. (APPENDIX 1)

Sample design

All participants were individuals undergoing orthognathic surgery treatment at the Department of Oral and Maxillofacial Surgery at the Federal University of Paraná. To be included in the study, participants must be 18 years of age or older, with full autonomy to make decisions, agree to participate in the study and sign the Free, Prior and Informed Consent Form (FPIC).

The following criteria were used to excluded participants from the study: individuals undergoing complex craniofacial surgeries, such as those with Le Fort II and III osteotomies; those who have undergone previous surgical treatment of the temporomandibular joint (TMJ); individuals undergoing TMJ surgery concomitantly with orthognathic surgery; in clinical treatment for temporomandibular joint disorders (TMD), using interocclusal devices or any medication to relieve symptoms (anti-inflammatories, analgesics or muscle relaxants); with previous history of facial surgeries, polyarthritis, trauma, pathologies, or syndromes involving the development and growth of the maxilla and mandible; need for reoperation during follow-up; facial trauma during follow-up affecting surgery results; or history of increased sensitivity to pain such as those with fibromyalgia.

Sample size calculation

Sample size calculation was performed using the website openepi.com, Version 3, open-source calculator, SSPropor (http://openepi.com/SampleSize/SSPropor.htm) and resulted in a sample size of 42 patients. The population size was considered as 96 patients seen in one year, with confidence level of 95%, hypothesized percentual frequency of outcome factor in the population of 5%[23,24] and 1:1 design effect.

Image Acquisition and measurements

The exams were performed on the i-CAT Cone Beam 3D Imaging System CT scanner (3D Imaging System, Imaging Sciences International Inc., Hatfield, PA, USA) with a FOV field of view of 16 x 13 cm, a resolution of 0.25 mm, 37.07 mAs, 120 kVp and exposure time of 26.9 seconds. Tomographic exams were carried out at the Imaging Teaching and Research Laboratory (LABIM) of the Federal University of Paraná.

The positioning of the patient was with the Camper plane being parallel to the ground, with the sagittal plane perpendicular to it. Camper's plane extends bilaterally from the lower edge of the ala of the nose to the tragus in the ear. The images were acquired at times T0 (pre-surgery), T1 (7 days after surgery) and T2 (6 months post-surgery).

The protocol for taking tomographic images were optimized to maximize resolution, reducing radiation dose, and minimizing the possibility of patient movement. Participants performed the exams seated with mouth closed and were oriented to relax the tongue against their front teeth and avoid flexing their neck. Exams were carried out with head stabilization straps and without chin support. After acquiring the images, they were processed on a workstation that has the i-Cat Vision software (Imaging Sciences International, Hatfield, USA), responsible for reconstructing the images. The computed tomography data were stored in "Digital Imaging and Communications in Medicine" (DICOM) format and transferred to a computer station with the free and open-source software ITK-SNAP (http://www.itksnap.org) for measurements.

All measurements and data analysis were carried out by a single investigator (FMZ), properly trained by an expert (gold standard) and calibrated. For calibration purposes, a total of 20 measurements were taken at intervals of more than 7 days (10 measurements in each phase). The number of tomographic images measured (10) was approximately 15% of the sample size, considering an estimated n=70. The tomographic images analyzed were of patients undergoing orthognathic surgery (pre- and post-surgery) from a previous database.

The intra-examiner reliability testing was carried out. The result of the statistical analysis of the intra-examiner calibration demonstrated excellent reliability, with Intraclass Correlation Coefficient (ICC) value of 0.995 (CI 0.983-0.999) for right mandibular condyle volume, 0.999 (CI 0.998-1.00) for left mandibular condyle volume and 0.991 (CI 0.965-0.998) for occlusal plane angle.

Image Orientation

The first step after importing the DICOM files into the software was correctly orienting the image in space for standardization. (Figure 1) The process began first in the sagittal view, using as a reference a line formed by the union of left porion and left orbitale points (Figure 1a), subsequently, the image was oriented in the axial view (Figure 1b), using as reference points the anterior nasal spine, posterior nasal spine, center of the body of the sphenoid bone and foramen magnum. Finally, the image was oriented in the coronal view (Figure 1c) with the frontozygomatic sutures as references.[17,18]

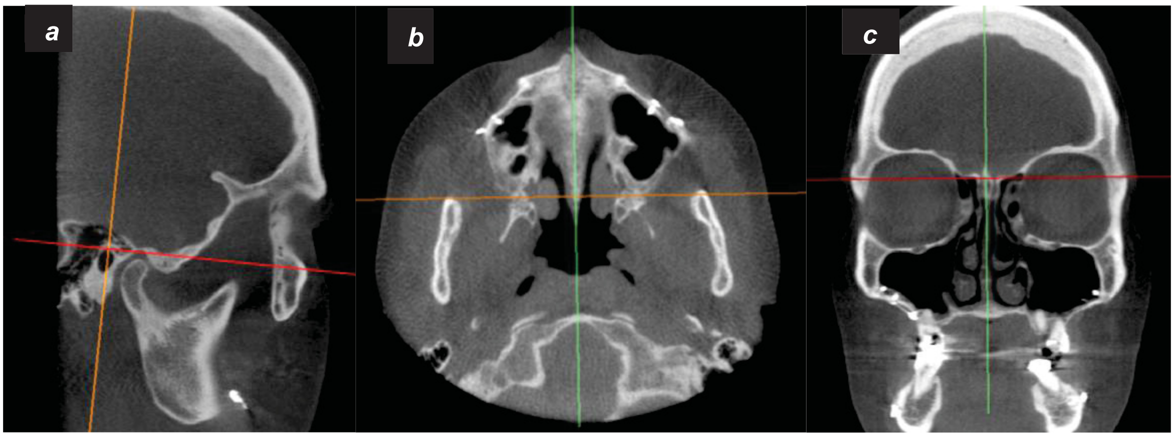


Figure 1. (1a) Image orientation in sagittal view. (1b). Image orientation in axial view. (1c). Image orientation in coronal view.
Source: the author.

Image Preparation

The second step began with the use of a semi-automatic tool called threshold which can classifies all pixels within a certain range (Hounsfield Scale) and can create masks for the different radiodensities of anatomical structures. This scale transforms the different shades of gray in the image into numerical values, allowing greater differentiation between similar tones. It was always necessary to check all image slices in all views (coronal, sagittal and axial) to verify whether the limits of the structures of interest were correctly delimited. If necessary, tools were used to fill spaces and adjust the contours. Then, the anatomical region to be measured could be isolated and a 3D volume created.

Measurement of Occlusal Plane angle

The occlusal Plane (OP) angle was obtained using the Frankfurt plane as a reference. The Frankfurt plane is the one that passes through the cephalometric points porion (the most superior and outer bony surface point of the external auditory meatus) and orbitale (most inferior point at the lower edge of the orbit), as shown in Figure 2. In this research, it was standardized the union of the right and left porion and left orbitale point for Frankfurt plane formation. The OP was formed by the union of an anterior point, located at the midpoint of contact between the upper and lower central incisors, with the intercuspation points between the upper and lower right and left first molars. In cases of anterior open bite or anterior crossbite, the anterior point was positioned at the midpoint of the distance between the incisal edges of the upper and lower incisors. In cases of absence of first molars, the second molars are used as a reference and the second premolars as a last alternative. After forming the two planes, the software calculated the occlusal plane angles with the roll, pitch, and yaw components (roll - rotation on X-axis; pitch - rotation on Y-axis; and yaw - rotation on Z-axis). For this study, we used the pitch angulation, which represent the angle or inclination of the occlusal plane in the sagittal view. By comparing the OP angles between the T0 (preoperative) and T1 (7 days after surgery) periods, it was possible to verify the direction of rotation (clockwise or counterclockwise), as well as quantify the magnitude of changes caused by surgery (in degrees).[19-21] For statistical purposes, the direction of rotation of the occlusal plane was considered as clockwise and counterclockwise. Minor rotations were considered between 0 and 2 degrees and major rotations, above 2 degrees, according to the median of the values found in the sample. Negative values were considered for counterclockwise rotations of the occlusal plane and positive values for clockwise rotations.

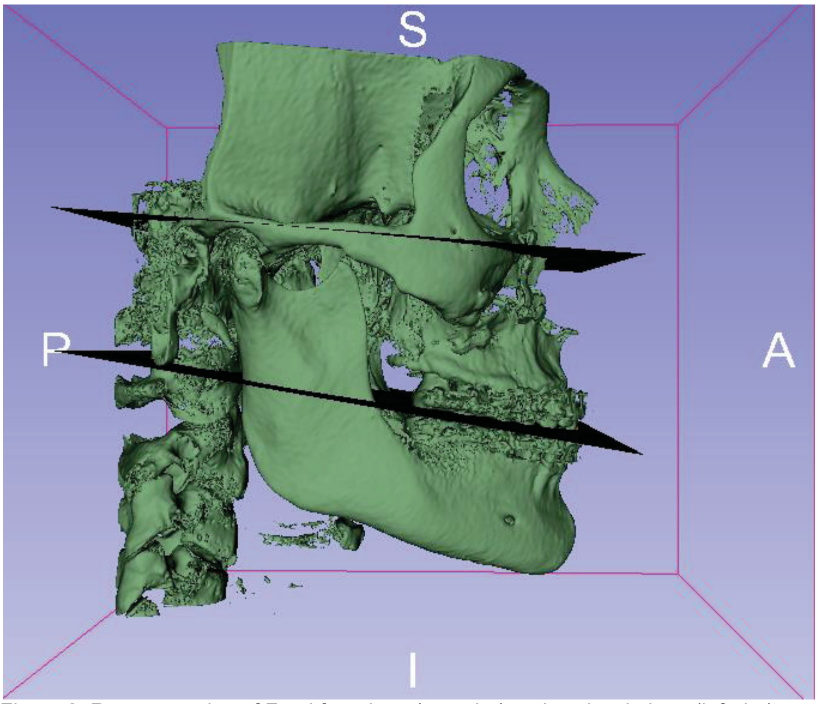


Figure 2. Representation of Frankfurt plane (superior) and occlusal plane (inferior).
Source: the author.

Volume of the mandibular condyles

For volumetric analysis of the mandibular condyles, a semi-automatic segmentation tool from the ITK-SNAP software. This tool selected where the image should be segmented in the axial, sagittal and coronal sections simultaneously. In this case, the following reference points are used to select the condyle: the lowest point of the mandibular notch, called InM and the point in the most anterior region of the articular eminence, called AEa. (Figure 3) To represent the semi-automatic selection tool, two lines are added to figure 3b, a line that touches the point AEa (RtE) and perpendicular to RtE is the line that touches the point InM (RtI). After delimiting the condyle, the volume was generated, based on the threshold range [UdMO1] (Lower threshold 350 – Upper threshold 3000).[22]

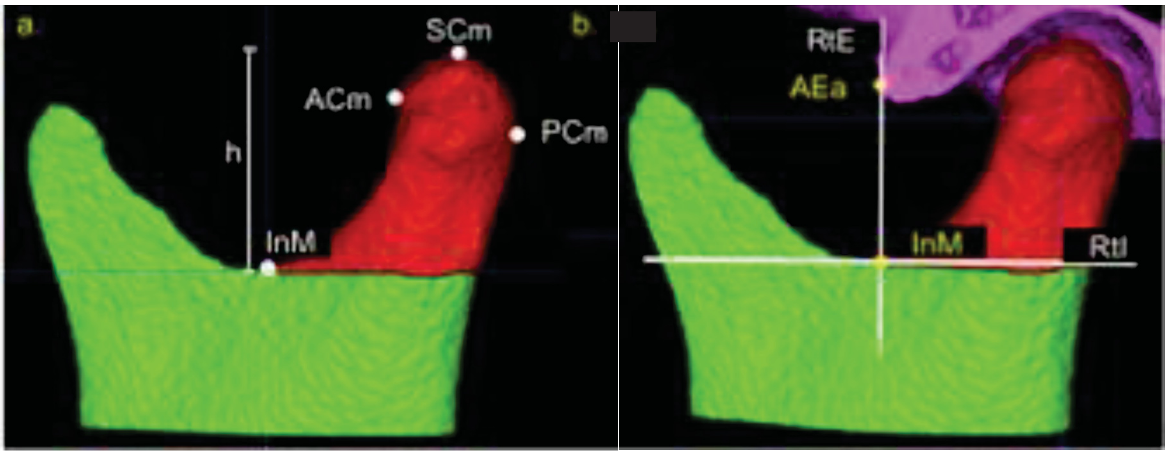


Figure 3. (3a) Lateral view of the condylar process, showing the posterior (PCm), anterior (ACm), superior (SCm), lowest point of the mandibular notch (InM) and the height (h) of the condyle. (3b) lowest point of the mandibular notch (InM), most anterior point of the articular eminence (AEa) straight line that touches the point AEa (RtE) and perpendicular to RtE is the straight line that touches the point InM (RtI). Source: the author.

Signs and Symptoms of Temporomandibular Disorder (TMD)

The diagnostic assessment of TMD was carried out using the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). The examiner (FMZ) was trained, calibrated by a gold standard, following the instructions contained in the published protocol.[23] The Kappa coefficient value of the intra-examiner analysis for applying the DC/TMD examination was 0.79.

The DC/TMD is the revised and updated version of the Research Diagnostic Criteria for Temporomandibular Disorders RDC/TMD, the most widely used diagnostic protocol for TMD research since its publication in 1992. This classification is intended to allow standardization and reproduction of results among researchers, clearly and objectively classifying patients with TMD. This classification system was based on a biopsychosocial model of pain that includes a physical assessment using reliable and well-operationalized diagnostic criteria and an assessment of psychosocial status and pain-related disability. Its intention is to simultaneously provide a physical diagnosis and identify other relevant characteristics of the individual that may influence the expression and, thus, the management of TMD.

This diagnostic tool has 2 axes – Axis 1 and Axis 2. For the objectives of the project, the following questionnaires and exams were selected from Axis 1: a) DC/TMD Symptom Questionnaires and b) DC/TMD Examination form. Regarding axis 2, the following questionnaires were chosen: a) Pain drawing; b) Generalized anxiety disorder – 7 (GAD 7); c) Patient health questionnaire – 15: Physical Symptoms; d) Oral Behavior Checklist (OBC). The final diagnosis was carried out using the DC/TMD Diagnostic Decision Tree. (ANNEX 1)

Statistics

The independent variables of this research were the rotation of the occlusal plane and the type of dentofacial deformity. The dependent variables were signs and symptoms of temporomandibular joint disorders and the volume of the mandibular condyles.

The variables related to the DC/TMD such as Muscular TMJ disorder, Articular joint disorder, Headache attributed to TMJ disorder, Right side joint disorder, Left side joint disorder, Degenerative joint disorder, Patient health questionnaire – 15: Physical Symptoms, Generalized anxiety disorder – 7 (GAD 7), Oral Behavior Checklist (OBC), Pain Drawing (Pain in the face, Pain beyond the face) were dichotomized into presence and absence. Dentofacial deformities variable were categorized into class I, II and III. Follow-up periods were categorized into T0 (preoperative), T1 (7 days postoperative) and T2 (6 months postoperative).

The normality of the distribution of variables occlusal plane rotation and mandibular condyle volume were assessed using the Kolmogorov-Smirnov test. The variables showed non-normal distribution.

The variables related to DC/TMD at times T0 and T2 were compared using McNemar test, McNemar-Bowker test, and Related-Samples Wilcoxon Signed Rank test. The correlation between the variables related to DC/TMD and occlusal plane rotation were evaluated using Pearson Chi-Square test, Fisher's Exact test, and McNemar-Bowker test.

The variables related to mandibular condyle volumes at times T0 and T2 were compared using Related-samples Friedman's two-way analysis of variance by ranks.

The correlation between the variables occlusal plane rotation and volume of the mandibular condyles were assessed by the Pearson Chi-Square test.

Relationship between sagittal classification of the dentofacial deformity and DC/TMD variables or dentofacial deformity was assessed by the Pearson Chi-Square test.

The significance level of 95% ($p < 0.05$) was adopted. Descriptive and inferential analyzes were performed using IBM® SPSS 20.0 Software (Statistical Package for Social Sciences, USA).

Results

Data were collected from 69 participants who agreed to participate in the research. After the end of the research period, applying the exclusion criteria and considering losses on follow-up, 50 participants remained as shown in Figure 4. According to sex, 54% were women (n=27) and 46% men (n=23). The median age was 29.5 years (min. 18 and max. 52). Thirty-eight participants were white (76%), six black (12%) and six mixed race (12%).

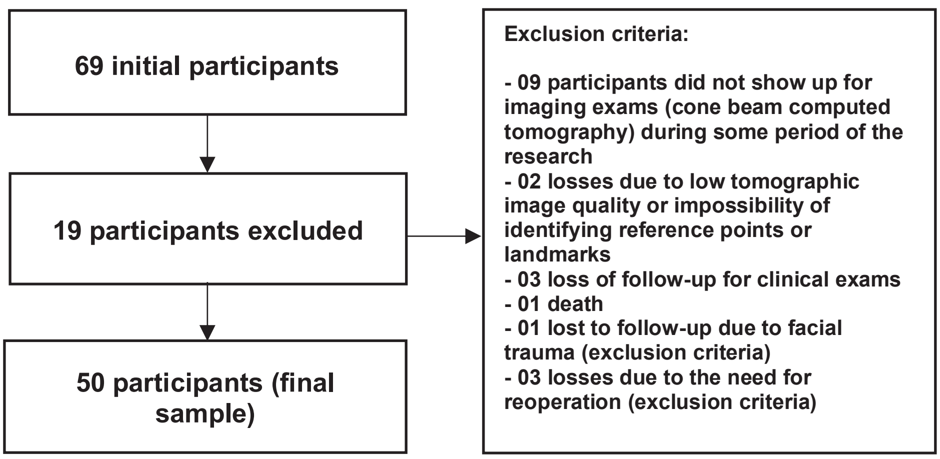


Figure 4. Flowchart of the sample with exclusion criteria and losses.

According to the type of sagittal skeletal deformity, we found 4% of class I (n=2); 38% of class II (n=19) and 58% of class III (n=29). Twenty-four counterclockwise rotations of the occlusal plane (48%) and 26 clockwise (52%) were performed. The quantitative rotation of the occlusal plane between T0 and T1 can be seen in Table 1.

Table 1. Magnitude of rotation of the occlusal plane from preoperative (T0) to immediate postoperative (T1) periods (degrees).

	Occlusal plane rotation from T0 to T1	
	Median (Min – Max)	n (%)
Counterclockwise rotation	-1.75 (-10.29 – -0.06)	24 (48%)
Clockwise rotation	1.97 (0.06 – 8.04)	26 (52%)

(-) minus sign shows counterclockwise rotation and positive values show clockwise rotation in degrees.

Minor rotations were 25 (50%) and major rotations 25 (50%). Of the minor rotations 13 (26%) were clockwise and 12 (24%) counterclockwise. Of the major rotations 13 (26%) were clockwise and 12 (24%) counterclockwise.

Signs and symptoms of TMD evaluated by axis I and II of the DC/TMD tool in the preoperative (T0) and 6-month postoperative periods (T2) can be seen in Table 2.

Table 2. TMD signs and symptoms on preoperative (T0) and 6-month postoperative periods (T2).

	Variable		Preoperative n (%)	6-month postoperative n (%)	*p* value
DC/TMD AXIS I	Muscular TMD	No	21 (42.9)	42 (84)	**<0.001***
		Yes	28 (57.1)	8 (16)	
	Articular joint disorder	No	29 (59.2)	44 (88)	**0.001***
		Yes	20 (40.8)	6 (12)	
	TMD and headache (Headache attributed to TMD)	No	36 (76.6)	47 (94)	**0.039***
		Yes	11 (23.4)	3 (6)	
	Right side joint disorder	No	31 (63.3)	40 (80)	**0.039***
		Yes	18 (36.7)	10 (20)	
	Left side joint disorder	No	30 (61.2)	39 (78)	**0.035***
		Yes	19 (38.8)	11 (22)	
	Degenerative joint disorder	No	49 (100)	48 (98)	- [a]
		Yes	0	1 (2)	
DC/TMD AXIS II	Patient health questionnaire – 15: Physical Symptoms	No	2 (4.1)	4 (8.2)	0.500
		Yes	47 (95.9)	45 (91.8)	
	Generalized anxiety disorder – 7 (GAD 7)	No	11 (22)	23 (46.9)	**<0.001***
		Yes	39 (78)	26 (53.1)	
	Oral Behavior Checklist (OBC)	No	3 (6)	4 (8.2)	1.000
		Yes	47 (94)	45 (91.8)	
	Pain Drawing	No	13 (32.5)	21 (44.7)	**<0.001#**
		Yes	27 (67.5)	26 (55.3)	
	Pain in the face	No	18 (36)	27 (55.1)	**0.031***
		Yes	32 (64)	22 (44.9)	
	Pain beyond the face	No	27 (54)	27 (56.2)	1.000
		Yes	23 (46)	21 (43.8)	

*McNemar Test, [a]McNemar-Bowker Test and #Related-Samples Wilcoxon Signed Rank Test with significance level of 5%.

Rotation of the occlusal plane did not prove to be an influencing factor in the signs and symptoms of temporomandibular disorders in this present sample, as shown in Table 3 and 4.

Table 3. TMD signs and symptoms related to counterclockwise occlusal plane rotations.

	Variable		minor counterclockwise rotation n (%)	major counterclockwise rotation n (%)	*p* value
DC/TMD AXIS I	Muscular TMD	No change	8 (66.7)	7 (58.3)	0.457*
		Better	3 (25)	5 (41.7)	
		Worse	1 (8.3)	0	
	Articular joint disorder	No change	10 (83.3)	7 (58.3)	0.255*
		Better	2 (16.7)	3 (25)	
		Worse	0	2 (16.7)	
	TMD and headache (Headache attributed to TMD)	No change	9 (81.8)	8 (66.7)	0.640#
		Better	2 (18.2)	4 (33.3)	
		Worse	0	0	
	Right side joint disorder	No change	11 (81.7)	8 (66.7)	0.176*
		Better	0	3 (25)	
		Worse	1 (8.3)	1 (8.3)	
	Left side joint disorder	No change	9 (75)	5 (41.7)	0.245*
		Better	2 (16.7)	4 (33.3)	
		Worse	1 (8.3)	3 (25)	
	Degenerative joint disorder	No change	12 (100)	11 (100)	- [a]
		Better	0	0	
		Worse	0	0	
DC/TMD AXIS II	Patient health questionnaire – 15: Physical Symptoms	No change	11 (91.7)	6 (50)	0.072*
		Better	1 (8.3)	4 (33.3)	
		Worse	0	2 (16.7)	
	Generalized anxiety disorder – 7 (GAD 7)	No change	5 (41.7)	6 (50)	0.580*
		Better	6 (50)	6 (50)	
		Worse	1 (8.3)	0	
	Oral Behavior Checklist (OBC)	No change	8 (66.7)	5 (41.7)	0.399*
		Better	3 (25)	4 (33.3)	
		Worse	1 (8.3)	3 (25)	
	Pain Drawing	No change	3 (25)	4 (33.3)	0.399*
		Better	8 (66.7)	5 (41.7)	
		Worse	1 (8.3)	3 (25)	
	Pain in the face	No change	6 (50)	8 (66.7)	0.386*
		Better	5 (41.7)	2 (16.7)	
		Worse	1 (8.3)	2 (16.7)	
	Pain Beyond the face	No change	9 (75)	10 (83.3)	0.824*
		Better	2 (16.7)	1 (8.3)	
		Worse	1 (8.3)	1 (8.3)	

*Pearson Chi-Square test, #Fisher's Exact Test and [a]McNemar-Bowker Test with significance level of 5%.

Table 4. TMD signs and symptoms related to clockwise occlusal plane rotations.

	Variable		minor clockwise rotation n (%)	major clockwise rotation n (%)	p value
DC/TMD AXIS I	Muscular TMD	No change	5 (41.7)	7 (53.8)	0.695#
		Better	7 (58.3)	6 (46.2)	
		Worse	0	0	
	Articular joint disorder	No change	6 (50)	7 (53.8)	1.000#
		Better	6 (50)	6 (46.2)	
		Worse	0	0	
	TMD and headache (Headache attributed to TMD)	No change	10 (90.9)	8 (61.5)	0.215*
		Better	1 (9.1)	3 (23.1)	
		Worse	0	2 (15.4)	
	Right side joint disorder	No change	9 (75)	8 (61.5)	0.559*
		Better	3 (25)	4 (30.8)	
		Worse	0	1 (7.7)	
	Left side joint disorder	No change	8 (66.7)	10 (76.9)	0.826*
		Better	3 (25)	2 (15.4)	
		Worse	1 (8.3)	1 (7.7)	
	Degenerative joint disorder	No change	12 (100)	12 (92.3)	1.000#
		Better	0	0	
		Worse	0	1 (7.7)	
DC/TMD AXIS II	Patient health questionnaire – 15: Physical Symptoms	No change	9 (81.8)	8 (61.5)	0.386#
		Better	2 (18.2)	5 (38.5)	
		Worse	0	0	
	Generalized anxiety disorder – 7 (GAD 7)	No change	9 (75)	5 (38.5)	0.157*
		Better	3 (25)	7 (53.8)	
		Worse	0	1 (7.7)	
	Oral Behavior Checklist (OBC)	No change	8 (66.7)	8 (61.5)	0.197*
		Better	2 (16.7)	5 (38.5)	
		Worse	2 (16.7)	0	
	Pain Drawing	No change	3 (25)	3 (23.1)	0.762*
		Better	7 (58.3)	9 (69.2)	
		Worse	2 (16.7)	1 (7.7)	
	Pain in the face	No change	8 (66.7)	9 (69.2)	0.559*
		Better	3 (25)	4 (30.8)	
		Worse	1 (8.3)	0	
	Pain Beyond the face	No change	9 (75)	9 (75)	0.717*
		Better	1 (8.3)	2 (16.7)	
		Worse	2 (16.7)	1 (8.3)	

*Pearson Chi-Square test and #Fisher's Exact Test with significance level of 5%.

The mandibular condyle volumes were evaluated between preoperative (T0) and 6 months postoperative (T2), and the results can be seen in Table 5.

Table 5. Mandibular condyle volumes at preoperative (T0) and 6-month postoperative (T2) periods (mm^3).

	Median (Minimum – Maximum)	*p value
Right mandibular condyle volume at T0	1766.44 (608.95 – 4014.05)	**0.011**
Right mandibular condyle volume at T2	1729.28 (595.80 – 3760.64)	
Left mandibular condyle volume at T0	1766.03 (574.84 – 3699.80)	0.572
Left mandibular condyle volume at T2	1796.14 (534.66 – 3617.21)	

*Related-samples Friedman's two-way analysis of variance by ranks with significance level of 5%.

Following, we present the quantitative analysis of changes in the volume of the mandibular condyles (in mm^3), presented like median (minimum – maximum) between T0 and T2 periods according to the direction of rotation of the occlusal plane. Minus sign shows decrease in volume and positive values show increase in volume. Right mandibular condyle volume variation for counterclockwise rotation: -19 (-253 – 43);

left mandibular condyle volume for counterclockwise rotation of OP: -15 (-128 – 177); right mandibular condyle volume variation for clockwise rotation of OP: -46 (-170 – 119); and left mandibular condyle volume variation for clockwise rotation of OP: 0 (-161 – 172).

Direction and magnitude of rotation of the occlusal plane did not prove to be an influencing factor for mandibular condyles volume in this present sample, as shown in Table 6 and 7.

Table 6. Clockwise rotation magnitude (minor and major) of the occlusal plane related to the volume of the mandibular condyles.

		Major clockwise occlusal plane rotation n (%)	Minor clockwise occlusal plane rotation n (%)	*p value
Right mandibular condyle volume	increase	5 (38.5)	3 (23.1)	0.395*
	decrease	8 (61.5)	10 (76.9)	
Left mandibular condyle volume	increase	8 (61.5)	5 (38.5)	0.239*
	decrease	5 (38.5)	8 (61.5)	

*Pearson Chi-Square with significance level of 5%.

Table 7. Counterclockwise rotation magnitude (minor and major) of the occlusal plane related to the volume of the mandibular condyles.

		Major counterclockwise occlusal plane rotation n (%)	Minor counterclockwise occlusal plane rotation n (%)	*p value
Right mandibular condyle volume	increase	6 (50)	2 (16.7)	0.083*
	decrease	6 (50)	10 (83.3)	
Left mandibular condyle volume	increase	4 (33.3)	6 (50)	0.408*
	decrease	8 (66.7)	6 (50)	

*Pearson Chi-Square with significance level of 5%.

The magnitude of rotation of the occlusal plane was significantly different between class II and III participants (p=0.003, Independent-Samples Mann Whitney U Test). Among class II patients (n=19), thirteen had counterclockwise and six clockwise rotations of the occlusal plane. Class III patients (n=29) had eleven counterclockwise and eighteen clockwise rotations of the occlusal plane. Next, we present the results like median (minimum – maximum) with minus sign showing counterclockwise direction and positive values clockwise direction of occlusal plane rotation. Nineteen class II participants (39.6%) with -1.26 (-10.29 – 2.87) and twenty-nine class III participants (60.4%) with 0.76 (-5.04 – 8.04).

Signs and symptoms of TMD were not shown to be different between class II and III participants undergoing orthognathic surgery during the follow-up period (Table 8).

Table 8. Relationship between sagittal Angle classification of the dentofacial deformity and TMD signs and symptoms.

	Variable		Class II n (%)	Class III n (%)	*p* value
DC/TMD AXIS I	Muscular TMD	No change	12 (63.2)	14 (50)	0.528*
		Better	7 (36.8)	13 (46.4)	
		Worse	0	1 (3.6)	
	Articular joint disorder	No change	10 (52.6)	19 (67.9)	0.179*
		Better	7 (36.8)	9 (32.1)	
		Worse	2 (10.5)	0	
	TMD and headache (Headache attributed to TMD)	No change	16 (94.1)	18 (64.3)	0.075*
		Better	1 (5.9)	8 (28.6)	
		Worse	0	2 (7.1)	
	Right side joint disorder	No change	15 (78.9)	19 (67.9)	0.249*
		Better	2 (10.5)	8 (28.6)	
		Worse	2 (10.5)	1 (3.6)	
	Left side joint disorder	No change	10 (52.6)	20 (71.4)	0.071*
		Better	4 (21.1)	7 (25)	
		Worse	5 (26.3)	1 (3.6)	
	Degenerative joint disorder	No change	18 100)	27 (96.4)	- [a]
		Better	0	0	
		Worse	0	1 (3.6)	
DC/TMD AXIS II	Patient health questionnaire – 15: Physical Symptoms	No change	13 (68.4)	21 (75)	0.213*
		Better	4 (21.1)	7 (25)	
		Worse	2 (10.5)	0	
	Generalized anxiety disorder – 7 (GAD 7)	No change	9 (47.4)	16 (57.1)	0.313*
		Better	10 (52.6)	10 (35.7)	
		Worse	0	2 (7.1)	
	Oral Behavior Checklist (OBC)	No change	12 (63.2)	17 (60.7)	0.520*
		Better	4 (21.1)	9 (32.1)	
		Worse	3 (15.8)	2 (7.1)	
	Pain Drawing	No change	7 (36.8)	6 (21.4)	0.213*
		Better	8 (42.1)	19 (67.9)	
		Worse	4 (21.1)	3 (10.7)	
	Pain in the face	No change	13 (68.4)	18 (64.3)	0.202*
		Better	3 (15.8)	9 (32.1)	
		Worse	3 (15.8)	1 (3.6)	
	Pain Beyond the face	No change	17 (89.5)	19 (70.4)	0.133*
		Better	0	5 (18.5)	
		Worse	2 (10.5)	3 (11.1)	

*Pearson Chi-Square Test with significance level of 5%.

The changes in the volume of the mandibular condyles were not significantly different between class II and III participants during the follow-up period as shown in Table 9.

Table 9. Relationship between sagittal Angle classification of the dentofacial deformity and volume of the mandibular condyles.

		Class II n (%)	Class III n (%)	*p* value
Right mandibular condyle volume	increase	5 (26.3)	10 (34.5)	0.551
	decrease	14 (73.7)	19 (65.5)	
Left mandibular condyle volume	increase	6 (31.6)	16 (55.2)	0.109
	decrease	13 (68.4)	13 (44.8)	

*Pearson Chi-Square Test with significance level of 5%.

Discussion

There is an increasing research interest, with many publications exploring factors associated with TMD in orthognathic surgery, such as condylar alterations, predisposing factors, signs, and symptoms of TMD, dental occlusion, and surgical techniques.[26] As far as we know, this is the only research to analyze the correlation between changes in the occlusal plane in orthognathic surgery with signs and symptoms of TMD and volume of the mandibular condyles.

Regarding the signs and symptoms of TMD between T0 (preoperative) and T2 (6-month postoperative) periods, results of this research found significant improvement in muscular TMD, joint disorder, as well as headache linked to TMD, right and left TMJ disorder. Concerning axis 2 of the DC/TMD, there was an improvement in the results from the questionnaires on generalized anxiety disorder, pain drawing, and pain in the face.

Temporomandibular disorder (TMD) is recognized as a variety of signs and symptoms related to the temporomandibular joint (TMJ).[27] The most common are arthralgia (articular pain), myofascial pain, muscular fatigue, headache, chewing or opening limitations, mouth deviations on movement, trismus, joint crepitation, joint clicking, and disc displacement. It can affect people from adolescence to adulthood, including patients with indication for orthognathic surgery.[28-30] TMD disorders typically have a multifactorial etiology. These factors include all kinds of anatomical variations (normal or pathological), psychological issues and the presence of parafunctional habits like bruxism (teeth grinding). The presence of dentofacial deformity alone cannot be considered a cause of TMD although studies indicate that patients with dentofacial deformities present greater prevalence of TMD.[27] Likewise, treating deformities through orthognathic surgery is until now, not scientifically proved to be related to TMD improvement. Meanwhile, some studies indicate that orthognathic surgery may cause TMD signs and symptoms to improve or worsen.[31-34] Also, patients without any TMD signs and symptoms can develop them after orthognathic surgery.[31,32] Corroborating some published research, our study found improvement in some signs and symptoms of TMD between preoperative and postoperative periods, with substantial improvement in muscular TMD, joint disorders, TMD-related headache, as well as in factors associated with anxiety and a reduction in pain points reported in the body and head region comparing with the preoperative period.

Our results found no correlation between the direction (clockwise and anticlockwise) and magnitude (major or minor) of occlusal plane rotation with signs and symptoms of TMD. Since TMD has multifactorial causes, it is possible that if there is an improvement or worsening of TMD, it should relate to the severity of the dentofacial deformity, anatomical factors, forces, and stress distribution on TMJ, muscular and soft tissue adaptability, surgical technique, emotional or psychological factors, and parafunctional oral habits.

We found statistically significant differences in the changes in volume of the mandibular head only for the right side between T0 and T2 periods. The association and clinical relevance between unilateral mandibular condyle volume variability is unknown and may be related to anatomical variations. Our hypothesis is that it could occur by chance, presence of specific anatomical characteristics, distribution of dentofacial deformities in the sample and presence of asymmetries.

No correlation was found between direction (clockwise and anticlockwise) and magnitude (major or minor) of occlusal plane rotation in the volume of the mandibular condyles between T0 and T2 periods. Changes, if occur, may be due to the amount of bone movement performed, decrease, or increase in the load or stress on the TMJ, mandibular condylar position changes, muscular and soft tissue adaptation, and postoperative occlusion.

The orthognathic surgery may influence the position of the temporomandibular joint, changing the pressure on the tissues[35], and being able to promote remodeling or even resorption of the mandibular condyles.[36-39] Research has shown that changes in position of the mandibular condyles occur following osteotomies and fixation of the mandible in orthognathic surgery.[40-42]

Although surgical occlusal plane rotation magnitude in degrees significantly differed between class II and III patients, results showed no difference in signs and symptoms of TMD between preoperative and 6-month postoperative, demonstrating in this sample that the sagittal component of dentofacial deformity did not influence the improvement or worsening of problems related to the temporomandibular joints.

Changes in mandibular condylar volume were similar between patients with class II and III deformities between T0 and T2 periods. The change in volume of the mandibular condyles may relate to the magnitude of the dentofacial deformity, the amount of bone repositioning carried out, as well as the possibility of tissue adaptation, surgical technique, genetic predisposition, as well as the presence of TMD or parafunctional habits in the postoperative period.

Although we have found an improvement in TMD signs and symptoms in the sample, this does not correlate with the direction and magnitude of the surgical rotation of the occlusal plane. Changes in the volume of the mandibular condyles were also not correlated with the direction and magnitude of the occlusal plane rotation caused by orthognathic surgery nor with the type of dentofacial deformity (class II or III).

The improvement and worsening of TMD signs and symptoms on postoperative period may be challenging to understand due to various confounding factors arising from the individuality of each participant, severity of the corrected facial deformity and its anatomical peculiarities.

Similarly, we believe that changes in the volume of the mandibular condyles during follow-up may relate to other factors, such as patient predisposition, anatomical characteristics, surgical technique, presence of parafunctional oral habits, TMD, severity of dentofacial deformity, forces distribution on the mandibular condyles and adaptability of the muscles and soft tissues.

One of the limitations of the research was the follow-up period. The initial plan was to have a follow-up period of one year. However, data collection one year postoperative was impossible due to problems linked to the COVID-19 pandemic and the research schedule. We strongly recommend future research with longer follow-up.

Much research has been done on the repercussions of maxillary and mandibular advances, setbacks, transversal, and vertical movements in orthognathic surgery on the temporomandibular joint. Some are even concerned with counterclockwise or clockwise rotations of the maxillomandibular complex, but not specifically with the occlusal plane. This is where we find a gap in knowledge on the theme. As changes to the occlusal plane are associated with most surgical plans in different magnitudes and directions, depending on the dentofacial deformity and the patient's facial type, we thought it would be very important to know what repercussions modifications in this plane could cause in the temporomandibular joint.

Conclusions

Although there was improvement in TMD signs and symptoms, this was not correlated with the direction and magnitude of occlusal plane rotation. The direction and magnitude of occlusal plane rotation caused by orthognathic surgery did not correlate with changes in the mandibular condyles volume.

References

1. Zere E, Chaudhari PK, Sharan J, Dhingra K, Tiwari N. Developing Class III malocclusions: challenges and solutions. Clin Cosmet Investig Dent. 2018 Jun 22;10:99-116.

2. Fish LC, Epker BN, Sullivan CR. Orthognathic surgery: the correction of dentofacial deformities. J Oral Maxillofac Surg. 1993 Jan;51(1 Suppl 1):28-41.

3. Obwegeser JA. Maxillary and midface deformities: characteristics and treatment strategies. Clin Plast Surg. 2007 Jul;34(3):519-33.

4. Reyneke JP. Surgical manipulation of the occlusal plane: new concepts in geometry. Int J Adult Orthodon Orthognath Surg. 1998;13(4):307-16.

5. Reyneke JP. Surgical cephalometric prediction tracing for the alteration of the occlusal plane by means of rotation of the maxillomandibular complex. Int J Adult Orthodon Orthognath Surg. 1999;14(1):55-64.

6. Reyneke JP, Evans WG. Surgical manipulation of the occlusal plane. Int J Adult Orthodon Orthognath Surg. 1990;5(2):99-110.

7. Lin HH, Chuang YF, Weng JL, Lo LJ. Comparative validity and reproducibility study of various landmark-oriented reference planes in 3-dimensional computed tomographic analysis for patients receiving orthognathic surgery. PLoS One. 2015;10(2):e0117604.

8. Wolford LM, Chemello PD, Hilliard FW. Occlusal plane alteration in orthognathic surgery. J Oral Maxillofac Surg. 1993 Jul;51(7):730-40; discussion 740-1.

9. Wolford LM, Chemello PD, Hilliard F. Occlusal plane alteration in orthognathic surgery-Part I: Effects on function and esthetics. Am J Orthod Dentofacial Orthop. 1994 Sep;106(3):304-16.

10. Sebastiani AM, Baratto-Filho F, Bonotto D, Kluppel LE, Rebellato NL, da Costa DJ, Scariot R. Influence of orthognathic surgery for symptoms of temporomandibular dysfunction. Oral Surg Oral Med Oral Pathol Oral Radiol. 2016 Feb;121(2):119-25.

11. Madhan S, Nascimento GG, Ingerslev J, Cornelis M, Pinholt EM, Cattaneo PM, Svensson P. Associations between temporomandibular disorders, pain, jaw and masticatory function in dentofacial deformity patients: A cross-sectional study. J Oral Rehabil. 2023 Sep;50(9):746-757.

12. Glovsky TE, Iwasaki LR, Wu Y, Liu H, Liu Y, Sousa Melo SL, Nickel JC. Orthognathic surgery effects on temporomandibular joint compressive stresses. Orthod Craniofac Res. 2023 Mar 31.

13. Gulcek BN, Ozbilen EO, Biren S. Changes in the condylar head after orthognathic surgery in Class III patients: a retrospective three-dimensional study. Angle Orthod. 2022 Nov 21;93(2):168–75.

14. da Silva RJ, Valadares Souza CV, Souza GA, Ambrosano GMB, Freitas DQ, Sant'Ana E, de Oliveira-Santos C. Changes in condylar volume and joint spaces after orthognathic surgery. Int J Oral Maxillofac Surg. 2018 Apr;47(4):511-517.

15. Hoppenreijs TJ, Freihofer HP, Stoelinga PJ, Tuinzing DB, van't Hof MA. Condylar remodeling and resorption after Le Fort I and bimaxillary osteotomies in patients with anterior open bite. A clinical and radiological study. Int J Oral Maxillofac Surg. 1998 Apr;27(2):81-91.

16. Kobayashi T, Izumi N, Kojima T, Sakagami N, Saito I, Saito C. Progressive condylar resorption after mandibular advancement. Br J Oral Maxillofac Surg. 2012 Mar;50(2):176-80.

17. Cevidanes L, Oliveira AE, Motta A, Phillips C, Burke B, Tyndall D. Head orientation in CBCT-generated cephalograms. Angle Orthod. 2009 Sep;79(5):971-7.

18. da Silva RJ, Valadares Souza CV, Souza GA, Ambrosano GMB, Freitas DQ, Sant'Ana E, de Oliveira-Santos C. Changes in condylar volume and joint spaces after orthognathic surgery. Int J Oral Maxillofac Surg. 2018 Apr;47(4):511-517.

19. Lin HH, Chuang YF, Weng JL, Lo LJ. Comparative validity and reproducibility study of various landmark-oriented reference planes in 3-dimensional computed tomographic analysis for patients receiving orthognathic surgery. PLoS One. 2015;10(2):e0117604.

20. Lonic D, Sundoro A, Lin HH, Lin PJ, Lo LJ. Selection of a horizontal reference plane in 3D evaluation: Identifying facial asymmetry and occlusal cant in orthognathic surgery planning. Sci Rep. 2017;7(1):2157.

21. Wan Z, Shen SG, Gui H, Zhang P, Shen S. Evaluation of the postoperative stability of a counterclockwise rotation technique for skeletal class II patients by using a novel three- dimensional position-posture method. Sci Rep. 2019;9(1):13196.

22. Schlueter B, Kim KB, Oliver D, Sortiropoulos G. Cone beam computed tomography 3D reconstruction of the mandibular condyle. Angle Orthod. 2008 Sep;78(5):880-8.

23. Ohrbach R, editor. Diagnostic Criteria for Temporomandibular Disorders: Assessment Instruments. Version 15May2016. www.rdc-tmdinternational.org Accessed on June 5, 2020.

24. Proffit WR, Fields HW Jr, Moray LJ. Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey. Int J Adult Orthodon Orthognath Surg. 1998;13(2):97-106.

25. Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. Eur J Orthod. 1989 Aug;11(3):309-20.

26. Grillo R, Brozoski MA, Samieirad S, Al-Moraissi EA, Cavalcante RCL, Naclério-Homem MDG. Global network mapping research findings on orthognathic surgery and temporomandibular disorder. J Stomatol Oral Maxillofac Surg. 2023 Oct;124(5):101531.

27. Miotto AV, Bonotto DV, Silva JSC, De Souza JF, Sebastiani AM, Scariot R. Temporomandibular disorders at the preoperative time of orthognathic surgery. diagnostics (Basel). 2023 Sep 12;13(18):2922.

28. Abdul NS, Minervini G. Prevalence of temporomandibular disorders in orthognathic surgery patients: A systematic review conducted according to PRISMA guidelines and the Cochrane Handbook for Systematic Reviews of Interventions. J Oral Rehabil. 2023 Oct;50(10):1093-1100.

29. Garcia MR, da Silva RD, Ferraz AX, Gonçalves FM, Santos RS, de Leão BLC, Nascimento WV, Schroder AGD, Zeigelboim BS, de Araujo CM. Prevalence of signs and symptoms related to temporomandibular disorders and orofacial pain in patients indicated for orthognathic surgery: a meta-analysis. Clin Oral Investig. 2023 Jul;27(7):3307-3319.

30. Uetanabaro LC, Gerber JT, Dos Santos KM, Meger MN, da Costa DJ, Küchler EC, Sebastiani AM, Scariot R. Prevalence and associated factors of myofascial pain in orthognathic patients with skeletal class II malocclusion. Oral Maxillofac Surg. 2023 Mar;27(1):25-31.

31. Al-Moraissi EA, Wolford LM, Perez D, Laskin DM, Ellis E 3rd. Does Orthognathic Surgery Cause or Cure Temporomandibular Disorders? A Systematic Review and Meta-Analysis. J Oral Maxillofac Surg. 2017 Sep;75(9):1835-1847.

32. Sebastiani AM, de Lucas Corso PFC, Bonotto D, de Souza JF, da Costa DJ, Scariot R, Rebellato NLB. Does orthognathic surgery improve myofacial pain in individuals with skeletal class III? One-year follow-up. Oral Surg Oral Med Oral Pathol Oral Radiol. 2018 Oct;126(4):322-330.

33. Madhan S, Nascimento GG, Ingerslev J, Cornelis M, Pinholt EM, Cattaneo PM, Svensson P. Associations between temporomandibular disorders, pain, jaw and masticatory function in dentofacial deformity patients: A cross-sectional study. J Oral Rehabil. 2023 Sep;50(9):746-757.

34. Bergamaschi IP, Cavalcante RC, Fanderuff M, Gerber JT, Petinati MFP, Sebastiani AM, da Costa DJ, Scariot R. Orthognathic surgery in class II patients: a longitudinal study on quality of life, TMD, and psychological aspects. Clin Oral Investig. 2021 Jun;25(6):3801-3808.

35. Glovsky TE, Iwasaki LR, Wu Y, Liu H, Liu Y, Sousa Melo SL, Nickel JC. Orthognathic surgery effects on temporomandibular joint compressive stresses. Orthod Craniofac Res. 2023 Mar 31.

36. Naik KY, Lee KC, Rekawek P, Zoida J, Torroni A. Remodeling of the temporomandibular joint after mandibular setback surgery: a 3D cephalometric analysis. J Oral Maxillofac Surg. 2023 Nov;81(11):1353-1359.

37. Luo YX, Chen ZH, Wang JN. Changes of temporomandibular joint morphology and symptoms in class II malocclusion patients with bilateral sagittal split ramous osteotomy. J Craniofac Surg. 2023 Oct 1;34(7):e655-e660.

38. Wang Z, Shi Y, Wang Y, Chen W, Jiang H, Cheng J. Three-dimensional quantitative changes of condyle in patients with skeletal class III malocclusion after bimaxillary orthognathic surgery with 5-year follow-up. Clin Oral Investig. 2023 Jul;27(7):4061-4071.

39. Takahara N, Tomomatsu N, Kimura A, Kosugi M, Kurasawa Y, Morita KI, Yoda T. Changes in the condylar volume and skeletal relapse following orthognathic surgery in patients with dentofacial deformity: A retrospective study. Cranio. 2022 May 4:1-11.

40. Kaur A, Rattan V, Rai S, Singh SP, Kalra P, Sharma S. Changes in condylar position after orthognathic surgery and its correlation with temporomandibular symptoms (TMD)- a prospective study. J Craniomaxillofac Surg. 2022 Dec;50(12):915-922.

41. Ravelo V, Olate G, de Moraes M, Huentequeo C, Sacco R, Olate S. Condylar positional changes in skeletal class II and class III malocclusions after bimaxillary orthognathic surgery. *Journal of Personalized Medicine*. 2023; 13(11):1544.

42. da Silva Félix Junior W, Klüppel LE, da Costa DJ, Fernandes Â, Scariot R, Rebellato NLB. Radiographic evaluation of condylar positioning in patients undergoing orthognathic surgery. Oral Maxillofac Surg. 2017 Dec;21(4):419-423.

4 ARTIGO 2

Title: What is the influence of sagittal occlusal plane rotation in orthognathic surgery on upper airway volume?

Abstract

Objective: this study focused on the question of whether the magnitude and direction of the occlusal plane rotation in patients undergoing orthognathic surgery influences the upper airway volume.
Materials and methods: this is an observational, longitudinal, prospective study in which data was collected in the preoperative and postoperative periods of 7 days and 6 months. All participants were individuals undergoing treatment with orthognathic surgery. To be included in the study, participants had to be 18 years of age or older, with full autonomy to make decisions, agree to take part in the study and sign the Free, Prior and Informed Consent Form (FPIC). The project was approved by the Research Ethics Committee in accordance with the Declaration of Helsinki. Cone beam computed tomography (CBCT) images were used to measure changes in occlusal plane angulation and upper airway volume between the preoperative and postoperative periods. The measurements were carried out by a single researcher, properly trained by a specialist (gold standard) and calibrated. A significance level of 95% ($p<0.05$) was adopted for statistical purpose.
Results: Data from 50 participants were evaluated 27 women (54%) and 23 men (46%). The median age was 29.5 years (min. 18 - max. 52). Skeletal deformity found was two class I (4%); nineteen class II (38%) and twenty-nine class III (58%). There were 24 counterclockwise (48%) and 26 clockwise (52%) rotations of the occlusal plane. Minor rotations (0 to 2 degrees) were 25 (50%) and major (above 2 degrees) were 25 (50%). There was a significant increase in the volume of the oropharynx in class II patients (p=0.026) and in volume of nasopharynx in class III patient (p=0.003). Although there was no significant difference between the amount of anteroposterior movement for the different directions of rotation of the occlusal plane in class II and III patients, we found significant results showing increased nasopharynx volume in both clockwise (p=0.035) and counterclockwise (p=0.037) rotations of the occlusal plane in class III patients.
Conclusion(s): There was significant correlation between the direction of rotation of the occlusal plane and changes in nasopharyngeal volume in class III. Class II patients had a significant increase in oropharyngeal volume and class III in nasopharyngeal volume during follow-up.

Introduction

Orthognathic surgery involves the repositioning of the maxilla and mandible to correct dentofacial deformities and can have a influence the volume, dimensions and shape of the upper airway.[1] The upper airway refers to the passage through which air travels from the nostrils and mouth to the lungs, including structures such as the nose, pharynx, and larynx.

Due to the importance of the subject, surgeons are concerned about which bone movements and its extension can cause the most effects on upper airway dimensions and their repercussions.[2]

In some cases where mandibular or maxillary anteroposterior deficiency contributes to the upper airway obstruction, surgical procedure for advancement (moving bones forward) can lead to an improvement in the air flow.[3,4] Mandibular setback surgery, which involves moving the lower jaw backward, may reduce the size of the upper airway, potentially contributing to constriction of the pharynx.[5]

For this reason, orthognathic surgery has also been considered in the management of obstructive sleep apnea (OSA), especially when the condition is associated with dentofacial deformities. Depending on the type of surgery and the extent of bone repositioning, it is possible for obstructive sleep apnea to worsen or improve[6,7]

Cone-beam computed tomography (CBCT) has become a valuable tool in the field oral and maxillofacial surgery for three-dimensional imaging. It is commonly used to assess craniofacial structures, including the upper airway. CBCT is particularly useful for evaluating changes in upper airway volume before and after orthognathic surgery. This is useful for evaluating the effectiveness of the surgical intervention and understanding the impact on respiratory function.[8]

CBCT allows segmentation and creation of three-dimensional models of the upper airway, providing a more comprehensive understanding of its shape and dimensions compared to traditional two-dimensional imaging. The process involves distinguishing the upper airway structures from surrounding tissues and bones. Besides, it can be employed in research studies investigating the relationship between craniofacial morphology and upper airway dimensions. These studies contribute to a better understanding of how changes in jaw position affect the upper airway.[9]

The benefits aside, studies have shown that care should be taken when interpreting and assessing dimensions of the upper airway using CBCT due to the possibility of errors, both in terms of the patient's head position, swallowing movement, and tong position at the time of scanning as well as operator errors when measuring in the software.[10]

Although many studies have investigated the repercussions of orthognathic surgery on the volume or dimension of the upper airway, this is the only study that has attempted to specifically correlate the modifications in the angulation of the occlusal plane caused by orthognathic surgery and changes in the volume of the upper airway.

The research hypothesis is that the volume of upper airway, should be altered by the modifications in the occlusal plane angulation caused by orthognathic surgery.

Materials and methods

Ethics

The project was approved by the Research Ethics Committee of the Health Sciences Sector at UFPR according to the Declaration of Helsinki.

Individuals were invited to participate in the study receive information regarding the research verbally. Those who agree to participate sign the Free, Prior and Informed Consent Form (FPIC), which explained the objectives and justifications for carrying out the study, as well as the benefits and risks. (APPENDIX 1)

Sample design

All participants were individuals undergoing orthognathic surgery treatment at the Department of Oral and Maxillofacial Surgery at the Federal University of Paraná. To be included in the study, participants must be 18 years of age or older, with full autonomy to make decisions, agree to participate in the study and sign the Free, Prior and Informed Consent Form (FPIC).

The following criteria were used to excluded participants from the study: individuals undergoing complex craniofacial surgeries, such as those with Le Fort II and III osteotomies; those who have undergone previous surgical treatment of the temporomandibular joint (TMJ); individuals undergoing TMJ surgery concomitantly with orthognathic surgery; in clinical treatment for temporomandibular joint disorders (TMD), using interocclusal devices or any medication to relieve symptoms (anti-inflammatories, analgesics or muscle relaxants); with previous history of facial surgeries, polyarthritis, trauma, pathologies, or syndromes involving the development and growth of the maxilla and mandible; need for reoperation during follow-up; facial trauma during follow-up affecting surgery results; or history of increased sensitivity to pain such as those with fibromyalgia.

Sample size calculation

Sample size calculation was performed using the website openepi.com, Version 3, open-source calculator, SSPropor (http://openepi.com/SampleSize/SSPropor.htm) and resulted in a sample size of 42 patients. The population size was considered as 96 patients seen in one year, with confidence level of 95%, hypothesized percentual frequency of outcome factor in the population of 5%[15,16] and 1:1 design effect.

Image Acquisition and measurements

The exams were performed on the i-CAT Cone Beam 3D Imaging System CT scanner (3D Imaging System, Imaging Sciences International Inc., Hatfield, PA, USA) with a FOV field of view of 16 x 13 cm, a resolution of 0.25 mm, 37.07 mAs, 120 kVp and exposure time of 26.9 seconds. Tomographic exams were carried out at the Imaging Teaching and Research Laboratory (LABIM) of the Federal University of Paraná.

The positioning of the patient was with the Camper plane being parallel to the ground, with the sagittal plane perpendicular to it. Camper's plane extends bilaterally from the lower edge of the ala of the nose to the tragus in the ear. The images were acquired at times T0 (preoperative) and T1 (6 months postoperative).

The protocol for taking tomographic images were optimized to maximize resolution, reducing radiation dose, and minimizing the possibility of patient movement. Participants performed the exams seated with mouth closed and were oriented to relax the tongue against their front teeth and avoid flexing their neck. Exams were carried out with head stabilization straps and without chin support. After acquiring the images, they were processed on a workstation that has the i-Cat Vision software (Imaging Sciences International, Hatfield, USA), responsible for reconstructing the images. The computed tomography data were stored in “Digital Imaging and Communications in

Medicine" (DICOM) format and transferred to a computer station with the free and open-source software ITK-SNAP (http://www.itksnap.org) for measurements.[8,9]

All measurements and data analysis were carried out by a single investigator (FMZ), properly trained by an expert (gold standard) and calibrated. For calibration purposes, a total of 20 measurements were taken at intervals of more than 7 days (10 measurements in each phase). The number of tomographic images measured (10) was approximately 15% of the sample size, considering an estimated n=70. The tomographic images analyzed were of patients undergoing orthognathic surgery (pre- and post-surgery) from a previous database. The intra-examiner reliability testing was carried out. The result of the statistical analysis of the intra-examiner calibration demonstrated excellent reliability, with Intraclass Correlation Coefficient (ICC) value of 0.996 (CI 0.976-0.999) for upper airway volume mensuration.

Image Orientation

The first step after importing the DICOM files into the software was correctly orienting the image in space for standardization. (Figure 1) The process began first in the sagittal view, using as a reference a line formed by the union of left porium and left orbitale points (Figure 1a), subsequently, the image was oriented in the axial view (Figure 1b), using as reference points the anterior nasal spine, posterior nasal spine, center of the body of the sphenoid bone and foramen magnum. Finally, the image was oriented in the coronal view (Figure 1c) with the frontozygomatic sutures as references.[11,12]

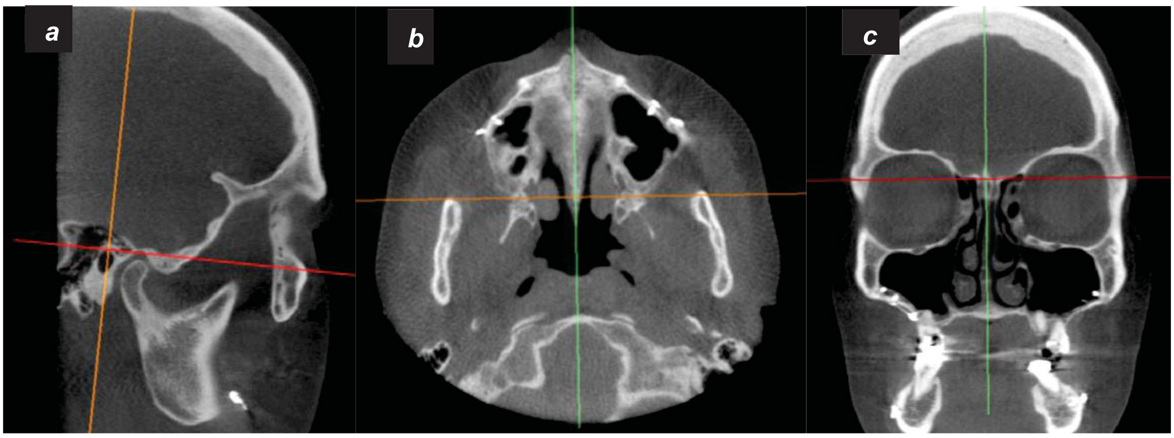


Figure 1. (1a) Image orientation in sagittal view. (1b). Image orientation in axial view. (1c). Image orientation in coronal view.
Source: the author.

Image Preparation

The second step began with the use of a semi-automatic tool called threshold which can classifies all pixels within a certain range (Hounsfield Scale) and can create masks for the different radiodensities of anatomical structures. This scale transforms the different shades of gray in the image into numerical values, allowing greater differentiation between similar tones. It was always necessary to check all image slices in all views (coronal, sagittal and axial) to verify whether the limits of the structures of interest were correctly delimited. If necessary, tools were used to fill spaces and adjust the contours. Then, the anatomical region to be measured could be isolated and a 3D volume created.

Upper airway volume measurement

The upper airway image was reconstructed from 3D images from cone beam computed tomography of the nasopharynx and oropharynx region. From there, a segmentation technique was used to represent the volume. Segmentation involved delimiting the area of interest for visualization or characterization of the anatomy through 3D reconstruction. The measurement of upper airway volume was performed using the three-dimensional model, based on reference points, landmarks and planes previously published.[13,14] The anatomical and technical limits for the upper airway segmentation are shown in Table 1. and Figure 2. a 3D image example of the upper airway (nasopharynx and oropharynx) after segmentation.

Table 1. Anatomical and technical limits of the upper airway.

Region	Limits	Anatomical	Technical
Nasopharynx	Anterior	*Frontal plane perpendicular to FH passing through PNS*	=
	Posterior	*Soft tissue contour of the pharyngeal wall*	*Frontal plane perpendicular to FH passing through C2sp*
	Upper	*Soft tissue contour of the pharyngeal wall*	*Transversal plane parallel to FH passing through the root of the clivus*
	Lower	*Plane parallel to FH passing through PNS and extended to the posterior wall of the pharynx*	=
	Lateral	*Soft tissue contour of the pharyngeal lateral walls*	*Sagittal plane perpendicular to FH passing through the lateral walls of the maxillary sinus*
Oropharynx	Anterior	*Frontal plane perpendicular to FH passing through PNS*	=
	Posterior	*Soft tissue contour of the pharyngeal wall*	*Frontal plane perpendicular to FH passing through C2sp*
	Upper	*Plane parallel to FH passing through PNS and extended to the posterior wall of the pharynx*	=
	Lower	*Plane parallel to FH plane passing through C3ai*	=
	Lateral	*Soft tissue contour of the pharyngeal lateral walls*	*Sagittal plane perpendicular to FH passing through the lateral walls of the maxillary sinus*

FH, Frankfort horizontal; PNS, posterior nasal spine; C2sp: superior–posterior extremity of the odontoid process of C2; C3ai, most anterior–inferior point of the body of C3.
Source: Guijarro-Martínez R and Swennen GR, 2013

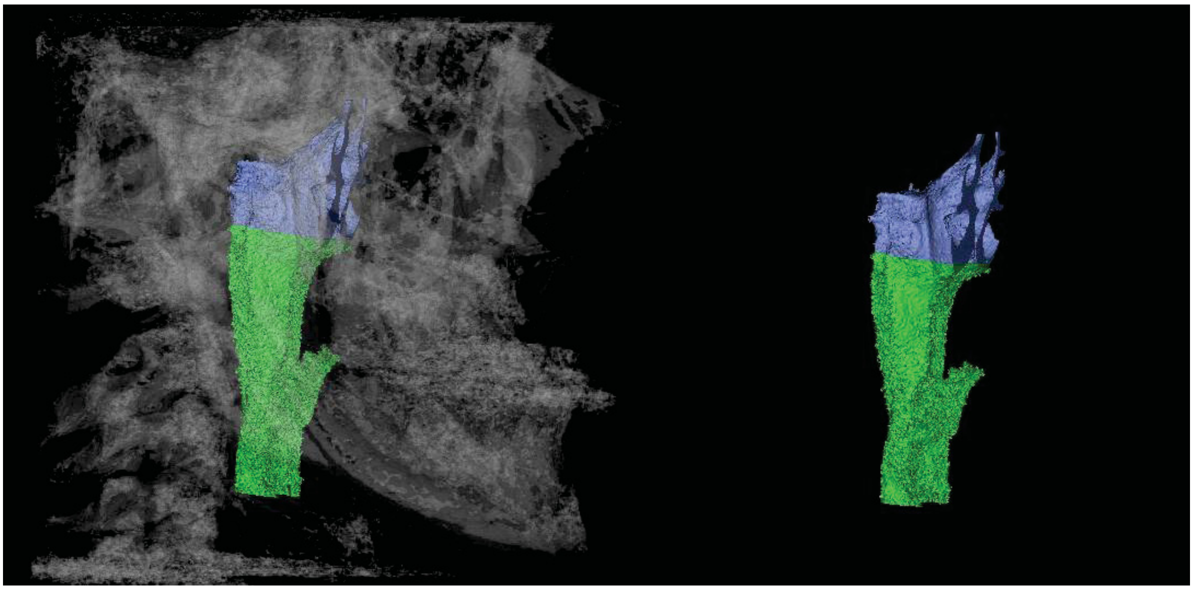


Figure 2. 3D image of upper airway (nasopharynx and oropharynx) after segmentation.
Source: the author.

Statistics

The independent variables of this study were the rotation of the occlusal plane and the type of dentofacial deformity. The dependent variable was the upper airway volume.

Dentofacial deformities variable were categorized into class I, II and III. Follow-up periods were categorized into T0 (preoperative) and T1 (6 months postoperative).

The normality of the distribution of the upper airway volume variable were assessed using the Kolmogorov-Smirnov test and showed a normal distribution

Analysis of changes in the upper airway volume between the preoperative and postoperative periods among class II and III patients was carried out using the Paired t-test.

Comparison between preoperative and postoperative changes in upper airway volume in class II and III patients in the different directions of rotation of the occlusal plane was carried out using the Paired t-test.

The comparison of anteroposterior maxillary and mandibular reposition in the different occlusal plane directions of rotations for class II and class III patients was carried out using the T test for equality of means.

The significance level of 95% ($p < 0.05$) was adopted. Descriptive and inferential analyzes were performed using IBM® SPSS 20.0 Software (Statistical Package for Social Sciences, USA).

Results

Data were collected from 69 participants who agreed to participate in the research. After the end of the research period, applying the exclusion criteria and considering losses on follow-up, 50 participants remained as shown in Figure 3. According to sex, 54% were women (n=27) and 46% men (n=23). The median age was 29.5 years (min. 18 and max. 52). Thirty-eight participants were white (76%), six black (12%) and six mixed race (12%).

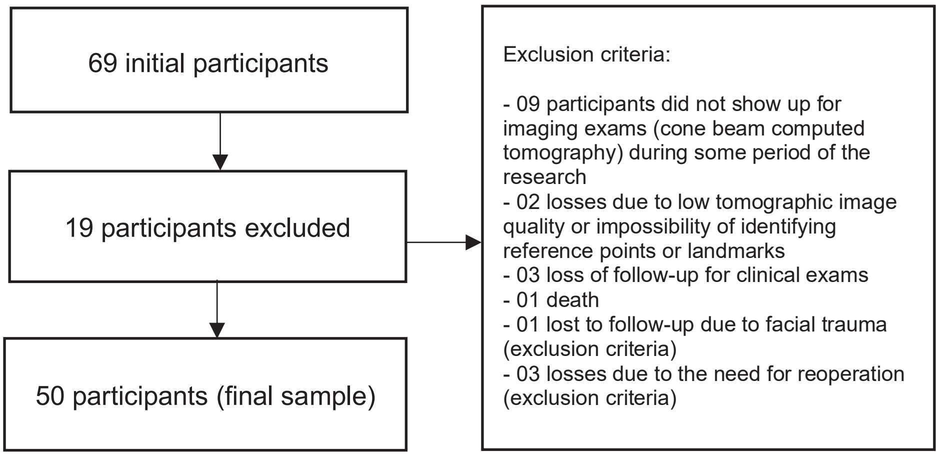


Figure 3. Flowchart of the sample with exclusion criteria and losses.

According to the type of sagittal skeletal deformity, we found 4% of class I (n=2); 38% of class II (n=19) and 58% of class III (n=29). Twenty-four counterclockwise rotations of the occlusal plane (48%) and 26 clockwise (52%) were performed.

The magnitude of rotation of the occlusal plane was significantly different between class II and III participants (*p*=0.003, Independent-Samples Mann Whitney U Test). Among class II patients (n=19), thirteen had counterclockwise and six clockwise rotations of the occlusal plane. Class III patients (n=29) had eleven counterclockwise and eighteen clockwise rotations of the occlusal plane. Next, we present the results like median (minimum – maximum) with minus sign showing counterclockwise direction and positive values clockwise direction of occlusal plane rotation. Nineteen class II participants (39.6%) with -1.26 (-10.29 – 2.87) and twenty-nine class III participants (60.4%) with 0.76 (-5.04 – 8.04).

Changes in nasopharyngeal and oropharyngeal volume between preoperative and postoperative period in class II and III patients can be seen in table 2.

Table 2. Changes in upper airway volume between preoperative and postoperative periods for class II and class III patients (in mm^3).

		Preoperative	Postoperative	Δ postop - preop	**p*
		Mean (SD)	Mean (SD)	Mean (SD)	*value*
Class II	Nasopharynx volume	7730.64 (2712.84)	7593.86 (2477.80)	-136.78 (838.93)	0.486
	Oropharynx volume	14247.22 (4790.65)	18131.98 (7193.25)	3884.76 (6275.21)	**0.026**
	Total volume	22269.07 (6651.62)	26069.78 (8793.70)	3800.71 (5971.19)	**0.022**
Class III	Nasopharynx volume	7341.36 (3039.33)	8782.63 (4096.83)	1441.26 (2355.02)	**0.003**
	Oropharynx volume	20113.28 (11911.71)	20118.53 (8761.48)	5.25 (8218.28)	0.997
	Total volume	27454.65 (14053.98)	28901.17 (11504.56)	1446.51 (8866.57)	0.387

*Paired t-test, with significance level of 5%.
SD = Standard Deviation

The association between preoperative and postoperative changes in upper airway volume in class II and III patients in the different directions of rotation of the occlusal plane (clockwise and counterclockwise) can be seen in Table 3 and 4.

Table 3. Comparison between preoperative and postoperative changes in upper airway volume in class II patients in the different directions of rotation of the occlusal plane (in mm^3).

	Class II							
	Clockwise occlusal plane rotation				Counterclockwise occlusal plane rotation			
	Preoperative Mean (SD)	Postoperative Mean (SD)	n	**p*	Preoperative Mean (SD)	Postoperative Mean (SD)	n	**p*
Nasopharynx volume	8065.14 (1809.67)	7689.23 (1961.61)	6	0.774	7576.26 (3097.25)	7549.84 (2756.68)	13	0.920
Oropharynx volume	14892.60 (4937.27)	23047.66 (5143.69)	5	0.076	13953.87 (4936.79)	16136.51 (7334.35)	11	0.307
Total Volume	23193.67 (6347.30)	30683.72 (6738.15)	5	0.175	21848.79 (7044.78)	24032.87 (9127.45)	11	0.276

*Paired t-test, with significance level of 5%.
SD = Standard Deviation

Table 4. Comparison between preoperative and postoperative changes in upper airway volume in class III patients in the different directions of rotation of the occlusal plane (in mm^3).

	Class III							
	Clockwise occlusal plane rotation				Counterclockwise occlusal plane rotation			
	Preoperative Mean (SD)	Postoperative Mean (SD)	n	**p*	Preoperative Mean (SD)	Postoperative Mean (SD)	n	**p*
Nasopharynx volume	7968.45 (3401.74)	9324.22 (4670.71)	18	**0.035**	6315.23 (2080.12)	7896.39 (2918.39)	11	**0.037**
Oropharynx volume	21490.97 (14360.53)	20484.16 (8733.89)	18	0.648	17858.90 (6140.04)	19520.24 (9199.25)	11	0.405
Total Volume	29459.42 (17019.31)	29808.38 (12457.14)	18	0.883	24174.13 (6446.00)	27416.63 (10143.04)	11	0.149

*Paired t-test, with significance level of 5%.
SD = Standard Deviation

The amount of anteroposterior maxillary and mandibular reposition (in mm) in the different occlusal plane directions of rotations for class II and class III patients is shown on Table 5. There was no significant difference between the amount of anteroposterior movement for the different directions of rotation of the occlusal plane between class II and III patients.

Table 5. Amount of anteroposterior movement of the jaws in relation to direction of rotations of the occlusal plane (clockwise and counterclockwise) in class II and III patients (in mm).

	Class II					Class III				
	CCW OP rotation		CW OP rotation			CCW OP rotation		CW OP rotation		
	Mean (SD)	n	Mean (SD)	n	*p	Mean (SD)	n	Mean (SD)	n	*p
Maxillary ANS_AP	0.82 (2.23)	13	0.66 (1.02)	6	0.833	4.93 (2.98)	11	5.98 (1.52)	18	0.297
Maxillary SCI_AP	1.96 (2.22)	13	0.67 (1.03)	6	0.101	5.25 (2.72)	11	5.26 (1.55)	18	0.985
Mandibular ICI_AP	6.17 (3.06)	13	5.93 (2.04)	6	0.837	0.01 (3.68)	11	0.71 (2.28)	18	0.578
Mandibular Point B_AP	7.20 (3.29)	13	5.58 (2.26)	6	0.233	0.45 (3.15)	11	0.13 (2.74)	18	0.785

*T test for equality of means, with significance level of 5%.
CW = clockwise, CCW = counterclockwise, OP = occlusal plane, SD = standard deviation
Maxilla ANS_AP = anteroposterior movement registered on Anterior Nasal Spine (ANS).
Maxilla CI_AP = anteroposterior movement registered on vestibular surface of the Superior Central Incisor (SCI).
Mandible CI_AP = anteroposterior movement registered on vestibular surface of the Inferior Central Incisor (ICI).
Mandible Point B_AP = anteroposterior movement registered on mandibular Point B cephalometric landmark.

Discussion

The upper airway is a dynamical structure that can be altered by the orthognathic surgery. The soft and hard tissues in this region play an important role in the anatomy and function of the airway. Changes in the upper airway can be expected following orthognathic surgery, and over time it may adapt for the new position of the bones. Upper airway dimensions tend to return to the initial position after orthognathic surgery. However, no complete return of the initial condition.[17]

Cone-beam computed tomography (CBCT) images are the most common exam to assess the upper airway dimensions. It is useful for evaluating changes in upper airway volume before and after orthognathic surgery. On the other hand, studies have assessed the reliability of measuring the dimensions of the upper airway using CBCT due to the possibility of errors, in terms of the patient's head position, swallowing movement, and tong position at the time of scanning.[8-10]

One of the main concerns of maxillofacial surgeons is to identify which bone movements can increase or decrease the dimensions of the upper airway, affecting airflow in patients undergoing orthognathic surgery.[2]

Le Fort I osteotomy surgery with superior repositioning or maxillary impaction is a usual procedure for vertical maxillary excess correction. Although volume of upper airway could decrease after this type of surgery, they are not significant and don’t seem to negatively affect the nasal airway.[18,19]

Maxillomandibular advancement has positive effects on upper airway volume increase in class II patients and also in class III patients with maxillary advancement and mandibular setback of no more than 4 mm.[20] Research indicates that the upper airway is not negatively affected after counterclockwise maxillomandibular advancement with multi-piece maxillary osteotomy and maxillary advancement with mandibular setback.[21] Other study, demonstrated that counterclockwise bimaxillary advancement produced a significant increase in nasopharynx, oropharynx, and hypopharynx volumes in the long term.[22]

Likewise, maxillomandibular advancement surgery increased the area and volume of the upper airway with a significant increase in the immediate post-operative period, with a progressive reduction during the postoperative period up to 5 years but remaining statistically significant.[23]

Research evaluating the impact of maxillary, mandibular, and bimaxillary advancement surgeries showed that the three advancement procedures increased the oropharyngeal airway volume significantly. Nasopharyngeal, oropharyngeal, and hypopharyngeal airway volumes responded in varying degrees to the different advancement surgeries. Isolated maxillary advancement and isolated mandibular advancement increases oropharyngeal volume significantly. In addition, the impact of comparable amounts of advancement of the maxilla and mandible are more noticeable for isolated maxillary advancement surgery. Bimaxillary advancement shows a more pronounced increase in pharyngeal compartments than the isolated maxillary and mandibular advancement surgeries.[24]

Isolated bilateral sagittal split osteotomy (BSSO) advancement surgery guides to a significant, and immediate increase in the total upper airway volume and surface area that remain stable after one year of follow-up.[25] Mandibular advancements higher than 10 mm shows a significant increase in the oropharynx dimension and the range of mandibular advancements expresses different effects in the upper airway volume.[26]

The single Le Fort I osteotomy for maxillary advancement with or without impaction was found to increase the oropharynx volume[27] and class II treatment with orthognathic surgery increased significantly the total and inferior oropharyngeal volumes, while the nasopharyngeal volume decreased.[28]

There is a positive correlation between sagittal direction and extension of the bone reposition and the changes in the dimensions of the upper airway. For this reason, for example, class II patients with a retrognathic mandible and with obstructive sleep apnea are expected to benefit from orthognathic surgery.[29] Large mandibular setback reposition can significantly reduce the pharyngeal airway dimensions.[7,30]

Other research show that the preoperative dimension of the upper airway and the extent of mandibular advancement are significantly correlated.[31] In another way, a study demonstrate that the mandible can be setback safely without decreasing airway dimensions.[32]

In our study we found a significant increase in the volume of the oropharynx in class II patients, which was due to mandibular advancement. Corroborating with the other research[33], there was a significant increase in nasopharyngeal volume in class III patients much of which was due to maxillary advancement movements. Although there was no significant difference between the amount of anteroposterior movement for the different directions of rotation of the occlusal plane in class II and III patients, we found significant results showing increased nasopharynx volume in both directions of occlusal plane rotation in class III patients. This shows that regardless of the direction of rotation of the occlusal plane in maxillary advancements, there is a positive effect on the increase in volume of the nasopharynx. This probably caused by the widening of the soft tissues of the nasopharynx in response to the new bone position. Due to limitations, our study had a 6-month follow-up, and we strongly recommend future research with longer periods.

In summary, changes in the volume of the upper airway respond differently to each type of surgery and depend on the direction and magnitude of the bone movements performed, the patient's dentofacial deformity and individual anatomical characteristics. Rotations of the occlusal plane do not appear to be causally related to the increase or decrease in airway volume, but rather an associated factor in some specific surgeries.

Conclusion

A significant correlation was found between the direction of rotation of the OP and changes in nasopharynx volume in class III patients, which means that the nasopharynx increased in volume in both clockwise and counterclockwise rotations of the OP. There was no correlation between the direction of rotation of the occlusal plane and changes in upper airway volume in class II patients. Class II patients had a significant increase in oropharynx volume and class III in the nasopharynx volume between the preoperative and postoperative periods.

References

1. Steegman R, Hogeveen F, Schoeman A, Ren Y. Cone beam computed tomography volumetric airway changes after orthognathic surgery: a systematic review. Int J Oral Maxillofac Surg. 2023 Jan;52(1):60-71.

2. Giralt-Hernando M, Valls-Ontañón A, Haas Junior OL, Masià-Gridilla J, Hernández-Alfaro F. What are the Surgical Movements in Orthognathic Surgery That Most Affect the Upper Airways? A Three-Dimensional Analysis. J Oral Maxillofac Surg. 2021 Feb;79(2):450-462.

3. Hassing GJ, The V, Shaheen E, Politis C, de Llano-Pérula MC. Long-term three-dimensional effects of orthognathic surgery on the pharyngeal airways: a prospective study in 128 healthy patients. Clin Oral Investig. 2022 Mar;26(3):3131-3139.

4. Marcussen L, Stokbro K, Aagaard E, Torkov P, Thygesen T. Changes in Upper Airway Volume Following Orthognathic Surgery. J Craniofac Surg. 2017 Jan;28(1):66-70.

5. Lee KC. Long-term evaluation of the upper airway following mandibular setback surgery in the patients with mandibular prognathism. J Oral Rehabil. 2023 Sep;50(9):840-844.

6. Valls-Ontañón A, Giralt-Hernando M, Zamora-Almeida G, Anitua E, Mazarro-Campos A, Hernández-Alfaro F. Does orthognathic surgery have an incidentally beneficial effect on mild or asymptomatic sleep apnoea? Int J Oral Maxillofac Surg. 2023 Dec;52(12):1255-1261.

7. Yang HJ, Jung YE, Kwon IJ, Lee JY, Hwang SJ. Airway changes and prevalence of obstructive sleep apnoea after bimaxillary orthognathic surgery with large mandibular setback. Int J Oral Maxillofac Surg. 2020 Mar;49(3):342-349.

8. Almuzian M, Ghatam HMA, Al-Muzian L. Assessing the validity of ITK-SNAP software package in measuring the volume of upper airway spaces secondary to rapid maxillary expansion. J Orthod Sci. 2018 Feb 15;7:7.

9. Pinheiro ML, Yatabe M, Ioshida M, Orlandi L, Dumast P, Trindade-Suedam IK. Volumetric reconstruction and determination of minimum crosssectional area of the pharynx in patients with cleft lip and palate: comparison between two different softwares. J Appl Oral Sci. 2018 Oct 4;26:e20170282.

10. Obelenis Ryan DP, Bianchi J, Ignácio J, Wolford LM, Gonçalves JR. Cone-beam computed tomography airway measurements: Can we trust them? Am J Orthod Dentofacial Orthop. 2019 Jul;156(1):53-60.

11. Cevidanes L, Oliveira AE, Motta A, Phillips C, Burke B, Tyndall D. Head orientation in CBCT-generated cephalograms. Angle Orthod. 2009 Sep;79(5):971-7.

12. da Silva RJ, Valadares Souza CV, Souza GA, Ambrosano GMB, Freitas DQ, Sant'Ana E, de Oliveira-Santos C. Changes in condylar volume and joint spaces after orthognathic surgery. Int J Oral Maxillofac Surg. 2018 Apr;47(4):511-517.

13. Guijarro-Martínez R, Swennen GR. Three-dimensional cone beam computed tomography definition of the anatomical subregions of the upper airway: a validation study. Int J Oral Maxillofac Surg. 2013 Sep;42(9):1140-9.

14. Alsufyani NA, Dietrich NH, Lagravère MO, Carey JP, Major PW. Cone beam computed tomography registration for 3-D airway analysis based on anatomic landmarks. Oral Surg Oral Med Oral Pathol Oral Radiol. 2014 Sep;118(3):371-83.

15. Proffit WR, Fields HW Jr, Moray LJ. Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey. Int J Adult Orthodon Orthognath Surg. 1998;13(2):97-106.

16. Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. Eur J Orthod. 1989 Aug;11(3):309-20.

17. Daluz ADJ, da Silva TVS, Tôrres BO, Costa DFN, Santos LAM. Long-term airway evolution after orthognathic surgery: Systematic Review. J Stomatol Oral Maxillofac Surg. 2022 Apr;123(2):191-198.

18. Yong CW, Quah B, Ng WH, Lai WMC, Sim YF, Wong RCW. Maxillary Impaction Does Not Negatively Affect the Nasal Airway: A Systematic Review With Meta-Analysis. J Oral Maxillofac Surg. 2023 Oct;81(10):1227-1243.

19. Vijayakumar Jain S, Muthusekhar MR, Baig MF, Senthilnathan P, Loganathan S, Abdul Wahab PU, Madhulakshmi M, Vohra Y. Evaluation of Three-Dimensional Changes in Pharyngeal Airway Following Isolated Lefort One Osteotomy for the Correction of Vertical Maxillary Excess: A Prospective Study. J Maxillofac Oral Surg. 2019 Mar;18(1):139-146.

20. Ravelo V, Olate G, Unibazo A, de Moraes M, Olate S. Retrospective Analysis of the Airway Space Changes in Dentofacial Deformity after Two-Jaw Orthognathic Surgery Using Cone Beam Computed Tomography. J Pers Med. 2023 Aug 14;13(8):1256.

21. Bin LR, Filho LI, Yamashita AL, de Souza Pinto GN, Mendes RA, Ramos AL, Dos Santos Previdelli IT, Iwaki LCV. How does bimaxillary orthognathic surgery change dimensions of maxillary sinuses and pharyngeal airway space? Angle Orthod. 2020 Sep 1;90(5):715-722.

22. Salazar AG, AlSulaiman A, Parsi G, Gunson M, Will LA, Motro M. Effects of counterclockwise bimaxillary advancement surgery and relapse on upper airway. Orthod Craniofac Res. 2023 Aug;26(3):510-523.

23. Araújo PM, Osterne RLV, de Souza Carvalho ACG, Azevedo NO, Gondim RF, Gonçalves Filho RT, Sant'Ana E, Nogueira RLM. Pharyngeal airway space changes after maxillomandibular advancement: a five-year retrospective study. Int J Oral Maxillofac Surg. 2019 Jun;48(6):732-738.

24. Parsi GK, Alsulaiman AA, Kotak B, Mehra P, Will LA, Motro M. Volumetric changes of the upper airway following maxillary and mandibular advancement using cone beam computed tomography. Int J Oral Maxillofac Surg. 2019 Feb;48(2):203-210.

25. Shujaat S, Shaheen E, Riaz M, Politis C, Jacobs R. Three-Dimensional Pharyngeal Airway Space Changes Following Isolated Mandibular Advancement Surgery in 120 Patients: A 1-Year Follow-up Study. J Imaging. 2022 Mar 22;8(4):82.

26. Lovisi CB, Assis NM, Marlière DA, Devito KL, Ritto FG, Medeiros PJ, Sotto-Maior BS. Immediate three-dimensional changes in the oropharynx after different mandibular advancements in counterclockwise rotation orthognathic planning. J Clin Exp Dent. 2021 Apr 1;13(4):e334-e341.

27. Almuzian M, Almukhtar A, Ju X, Al-Hiyali A, Benington P, Ayoub A. Effects of Le Fort I Osteotomy on the Nasopharyngeal Airway-6-Month Follow-Up. J Oral Maxillofac Surg. 2016 Feb;74(2):380-91.

28. Kim M, Hwang CJ, Cha JY, Lee SH, Kim YJ, Yu HS. Correlation Analysis betweenThree-Dimensional Changes in Pharyngeal Airway Space and Skeletal Changes in Patients with Skeletal Class II Malocclusion following Orthognathic Surgery. Biomed Res Int. 2022 Jan 11;2022:3995690.

29. Pellby D, Bengtsson M. Changes in the upper airway volume after orthognathic surgery: three-dimensional measurements in a supine body position. Int J Oral Maxillofac Surg. 2023 Sep;52(9):948-955.

30. Zhang Z, Wang S, Li J, Yang Z, Zhang X, Bai X. Quantification of pharyngeal airway space changes after two-jaw orthognathic surgery in skeletal class III patients. BMC Oral Health. 2023 Jun 1;23(1):345.

31. Trevisiol L, Bersani M, Sanna G, Nocini R, D'Agostino A. Posterior airways and orthognathic surgery: What really matters for successful long-term results? Am J Orthod Dentofacial Orthop. 2022 May;161(5):e486-e497.

32. Havron AG, Aronovich S, Shelgikar AV, Kim HL, Conley RS. 3D Airway changes using CBCT in patients following mandibular setback surgery ± maxillary advancement. Orthod Craniofac Res. 2019 May;22 Suppl 1:30-35.

33. Li H, Sun C, Chen Y, Sun Z, Gao X. Quantitative changes of upper airway in class III patients undergoing bimaxillary surgery after one-year follow-up: a retrospective study. Head Face Med. 2022 Apr 19;18(1):14.

5 CONCLUSÃO

Embora tenha havido melhorias significativas nos sinais e sintomas de DTM, estas não foram correlacionadas com o sentido e magnitude da rotação do plano oclusal ocasionada pela cirurgia ortognática. O sentido e a magnitude da rotação do plano oclusal ocasionada pela cirurgia ortognática não se correlacionaram com as alterações no volume das cabeças da mandíbula.

Houve uma correlação significativa entre o sentido de rotação do PO e as alterações de volume da nasofaringe nos pacientes classe III, o que significa que a nasofaringe aumentou de volume tanto na rotação sentido horário quanto no anti-horário. Não houve correlação entre o sentido de rotação do plano oclusal e as alterações de volume da via aérea superior nos pacientes classe II. Os pacientes classe II apresentaram um aumento significativo no volume da orofaringe e os classe III no volume da nasofaringe entre os períodos pré-operatório e pós-operatório.

6 REFERÊNCIAS

Abdul NS, Minervini G. Prevalence of temporomandibular disorders in orthognathic surgery patients: A systematic review conducted according to PRISMA guidelines and the Cochrane Handbook for Systematic Reviews of Interventions. J Oral Rehabil. 2023 Oct;50(10):1093-1100.

Al-Moraissi EA, Wolford LM, Perez D, Laskin DM, Ellis E 3rd. Does Orthognathic Surgery Cause or Cure Temporomandibular Disorders? A Systematic Review and Meta-Analysis. J Oral Maxillofac Surg. 2017 Sep;75(9):1835-1847.

Almuzian M, Almukhtar A, Ju X, Al-Hiyali A, Benington P, Ayoub A. Effects of Le Fort I Osteotomy on the Nasopharyngeal Airway-6-Month Follow-Up. J Oral Maxillofac Surg. 2016 Feb;74(2):380-91.

Almuzian M, Ghatam HMA, Al-Muzian L. Assessing the validity of ITK-SNAP software package in measuring the volume of upper airway spaces secondary to rapid maxillary expansion. J Orthod Sci. 2018 Feb 15;7:7.

Alsufyani NA, Dietrich NH, Lagravère MO, Carey JP, Major PW. Cone beam computed tomography registration for 3-D airway analysis based on anatomic landmarks. Oral Surg Oral Med Oral Pathol Oral Radiol. 2014 Sep;118(3):371-83.

An SB, Park SB, Kim YI, Son WS. Effect of post-orthognathic surgery condylar axis changes on condylar morphology as determined by 3-dimensional surface reconstruction. Angle Orthod. 2014 Mar;84(2):316-21.

Araújo PM, Osterne RLV, de Souza Carvalho ACG, Azevedo NO, Gondim RF, Gonçalves Filho RT, Sant'Ana E, Nogueira RLM. Pharyngeal airway space changes after maxillomandibular advancement: a five-year retrospective study. Int J Oral Maxillofac Surg. 2019 Jun;48(6):732-738.

Bauer, re 3rd, Ochs, MW. Maxillary orthognathic surgery. Oral and Maxillofacial Surgery Clinics of North America, v. 26, n. 4, p. 523-537, 2014.

Bergamaschi IP, Cavalcante RC, Fanderuff M, Gerber JT, Petinati MFP, Sebastiani AM, da Costa DJ, Scariot R. Orthognathic surgery in class II patients: a longitudinal study on quality of life, TMD, and psychological aspects. Clin Oral Investig. 2021 Jun;25(6):3801-3808.

Bin LR, Filho LI, Yamashita AL, de Souza Pinto GN, Mendes RA, Ramos AL, Dos Santos Previdelli IT, Iwaki LCV. How does bimaxillary orthognathic surgery change dimensions of maxillary sinuses and pharyngeal airway space? Angle Orthod. 2020 Sep 1;90(5):715-722.

Brevi BC, Toma L, Pau M, Sesenna E. Counterclockwise rotation of the occlusal plane in the treatment of obstructive sleep apnea syndrome. J Oral Maxillofac Surg. 2011 Mar;69(3):917-23.

Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. Eur J Orthod. 1989 Aug;11(3):309-20.

Cevidanes L, Oliveira AE, Motta A, Phillips C, Burke B, Tyndall D. Head orientation in CBCT-generated cephalograms. Angle Orthod. 2009 Sep;79(5):971-7.

Chang CS, Wallace CG, Hsiao YC, et al. Airway Changes after Cleft Orthognathic Surgery Evaluated by Three-Dimensional Computed Tomography and Overnight Polysomnographic Study. Sci Rep. 2017;7(1):12260.

Choi JW, Park YJ, Lee CY. Posterior Pharyngeal Airway in Clockwise Rotation of Maxillomandibular Complex Using Surgery-first Orthognathic Approach. Plast Reconstr Surg Glob Open. 2015 Aug 20;3(8):e485.

da Silva Félix Junior W, Klüppel LE, da Costa DJ, Fernandes Â, Scariot R, Rebellato NLB. Radiographic evaluation of condylar positioning in patients undergoing orthognathic surgery. Oral Maxillofac Surg. 2017 Dec;21(4):419-423.

da Silva RJ, Valadares Souza CV, Souza GA, Ambrosano GMB, Freitas DQ, Sant'Ana E, de Oliveira-Santos C. Changes in condylar volume and joint spaces after orthognathic surgery. Int J Oral Maxillofac Surg. 2018 Apr;47(4):511-517.

Daluz ADJ, da Silva TVS, Tôrres BO, Costa DFN, Santos LAM. Long-term airway evolution after orthognathic surgery: Systematic Review. J Stomatol Oral Maxillofac Surg. 2022 Apr;123(2):191-198.

de Souza Carvalho AC, Magro Filho O, Garcia IR Jr, Araujo PM, Nogueira RL. Cephalometric and three-dimensional assessment of superior posterior airway space after maxillomandibular advancement. Int J Oral Maxillofac Surg. 2012 Sep;41(9):1102-11.

Downs WB. Variations in facial relationship: Their significance in treatment and Prognosis. Angle Orthod 1949 07/01;19(3):145-55.

Eslamipour F, Najimi A, Tadayonfard A, Azamian Z. Impact of Orthognathic Surgery on Quality of Life in Patients with Dentofacial Deformities. Int J Dent. 2017;2017:4103905.

Fish LC, Epker BN, Sullivan CR. Orthognathic surgery: the correction of dentofacial deformities. J Oral Maxillofac Surg. 1993 Jan;51(1 Suppl 1):28-41.

Garcia MR, da Silva RD, Ferraz AX, Gonçalves FM, Santos RS, de Leão BLC, Nascimento WV, Schroder AGD, Zeigelboim BS, de Araujo CM. Prevalence of signs and symptoms related to temporomandibular disorders and orofacial pain in patients indicated for orthognathic surgery: a meta-analysis. Clin Oral Investig. 2023 Jul;27(7):3307-3319.

Gateno J, Alfi D, Xia JJ, Teichgraeber JF. A Geometric Classification of Jaw Deformities. J Oral Maxillofac Surg. 2015 Dec;73(12 Suppl):S26-31.

Giralt-Hernando M, Valls-Ontañón A, Haas Junior OL, Masià-Gridilla J, Hernández-Alfaro F. What are the Surgical Movements in Orthognathic Surgery That Most Affect the Upper Airways? A Three-Dimensional Analysis. J Oral Maxillofac Surg. 2021 Feb;79(2):450-462.

Glovsky TE, Iwasaki LR, Wu Y, Liu H, Liu Y, Sousa Melo SL, Nickel JC. Orthognathic surgery effects on temporomandibular joint compressive stresses. Orthod Craniofac Res. 2023 Mar 31.

Grillo R, Brozoski MA, Samieirad S, Al-Moraissi EA, Cavalcante RCL, Naclério-Homem MDG. Global network mapping research findings on orthognathic surgery and temporomandibular disorder. J Stomatol Oral Maxillofac Surg. 2023 Oct;124(5):101531.

Guijarro-Martínez R, Swennen GR. Three-dimensional cone beam computed tomography definition of the anatomical subregions of the upper airway: a validation study. Int J Oral Maxillofac Surg. 2013 Sep;42(9):1140-9.

Gulcek BN, Ozbilen EO, Biren S. Changes in the condylar head after orthognathic surgery in Class III patients: a retrospective three-dimensional study. Angle Orthod. 2022 Nov 21;93(2):168–75.

Hart PS, McIntyre BP, Kadioglu O, Currier GF, Sullivan SM, Li J, Shay C. Postsurgical volumetric airway changes in 2-jaw orthognathic surgery patients. Am J Orthod Dentofacial Orthop. 2015 May;147(5):536-46.

Hassing GJ, The V, Shaheen E, Politis C, de Llano-Pérula MC. Long-term three-dimensional effects of orthognathic surgery on the pharyngeal airways: a prospective study in 128 healthy patients. Clin Oral Investig. 2022 Mar;26(3):3131-3139.

Hatab NA, Konstantinović VS, Mudrak JK. Pharyngeal airway changes after mono- and bimaxillary surgery in skeletal class III patients: Cone-beam computed tomography evaluation. J Craniomaxillofac Surg. 2015 May;43(4):491-6.

Havron AG, Aronovich S, Shelgikar AV, Kim HL, Conley RS. 3D Airway changes using CBCT in patients following mandibular setback surgery ± maxillary advancement. Orthod Craniofac Res. 2019 May;22 Suppl 1:30-35.

Herford, AS, Stringer, DE; Tandon, R. Mandibular surgery. Oral and Maxillofacial Surgery Clinics of North America, v. 26, n. 4, p. 487-521, 2014.

Hoppenreijs TJ, Freihofer HP, Stoelinga PJ, Tuinzing DB, van't Hof MA. Condylar remodeling and resorption after Le Fort I and bimaxillary osteotomies in patients with anterior open bite. A clinical and radiological study. Int J Oral Maxillofac Surg. 1998 Apr;27(2):81-91.

Kahnberg, KE, Hagberg, C. The approach to dentofacial skeletal deformities using a multisegmentation technique. Clinics in Plastic Surgery, v. 34, n. 3, p. 477- 484, 2007.

Kaur A, Rattan V, Rai S, Singh SP, Kalra P, Sharma S. Changes in condylar position after orthognathic surgery and its correlation with temporomandibular symptoms (TMD)- a prospective study. J Craniomaxillofac Surg. 2022 Dec;50(12):915-922.

Kim M, Hwang CJ, Cha JY, Lee SH, Kim YJ, Yu HS. Correlation Analysis betweenThree-Dimensional Changes in Pharyngeal Airway Space and Skeletal Changes in Patients with Skeletal Class II Malocclusion following Orthognathic Surgery. Biomed Res Int. 2022 Jan 11;2022:3995690.

Kobayashi T, Izumi N, Kojima T, Sakagami N, Saito I, Saito C. Progressive condylar resorption after mandibular advancement. Br J Oral Maxillofac Surg. 2012 Mar;50(2):176-80.

Krisjane Z, Urtane I, Gardovska K, Jankovska I, Krumina G. The relationship between mandibular rotation and osseous structure of the TMJ in pre-surgery orthognathic patients: A cone beam CT study. Stomatologija. 2015;17(2):41-7.

Lee KC. Long-term evaluation of the upper airway following mandibular setback surgery in the patients with mandibular prognathism. J Oral Rehabil. 2023 Sep;50(9):840-844.

Li H, Sun C, Chen Y, Sun Z, Gao X. Quantitative changes of upper airway in class III patients undergoing bimaxillary surgery after one-year follow-up: a retrospective study. Head Face Med. 2022 Apr 19;18(1):14.

Lin HH, Chuang YF, Weng JL, Lo LJ. Comparative validity and reproducibility study of various landmark-oriented reference planes in 3-dimensional computed tomographic analysis for patients receiving orthognathic surgery. PLoS One. 2015;10(2):e0117604.

Lonic D, Sundoro A, Lin HH, Lin PJ, Lo LJ. Selection of a horizontal reference plane in 3D evaluation: Identifying facial asymmetry and occlusal cant in orthognathic surgery planning. Sci Rep. 2017;7(1):2157.

Lovisi CB, Assis NM, Marlière DA, Devito KL, Ritto FG, Medeiros PJ, Sotto-Maior BS. Immediate three-dimensional changes in the oropharynx after different mandibular advancements in counterclockwise rotation orthognathic planning. J Clin Exp Dent. 2021 Apr 1;13(4):e334-e341.

Luo YX, Chen ZH, Wang JN. Changes of temporomandibular joint morphology and symptoms in class II malocclusion patients with bilateral sagittal split ramous osteotomy. J Craniofac Surg. 2023 Oct 1;34(7):e655-e660.

Madhan S, Nascimento GG, Ingerslev J, Cornelis M, Pinholt EM, Cattaneo PM, Svensson P. Associations between temporomandibular disorders, pain, jaw and masticatory function in dentofacial deformity patients: A cross-sectional study. J Oral Rehabil. 2023 Sep;50(9):746-757.

Marcussen L, Stokbro K, Aagaard E, Torkov P, Thygesen T. Changes in Upper Airway Volume Following Orthognathic Surgery. J Craniofac Surg. 2017 Jan;28(1):66-70.

Mattos CT, Vilani GN, Sant'Anna EF, Ruellas AC, Maia LC. Effects of orthognathic surgery on oropharyngeal airway: a meta-analysis. Int J Oral Maxillofac Surg. 2011 Dec;40(12):1347-56.

Miotto AV, Bonotto DV, Silva JSC, De Souza JF, Sebastiani AM, Scariot R. Temporomandibular disorders at the preoperative time of orthognathic surgery. diagnostics (Basel). 2023 Sep 12;13(18):2922.

Monson, LA. Bilateral sagittal split osteotomy. Seminars in Plastic Surgery, v. 27, n. 3, p. 145-148, 2013.

Naik KY, Lee KC, Rekawek P, Zoida J, Torroni A. Remodeling of the temporomandibular joint after mandibular setback surgery: a 3D cephalometric analysis. J Oral Maxillofac Surg. 2023 Nov;81(11):1353-1359.

Obelenis Ryan DP, Bianchi J, Ignácio J, Wolford LM, Gonçalves JR. Cone-beam computed tomography airway measurements: Can we trust them? Am J Orthod Dentofacial Orthop. 2019 Jul;156(1):53-60.

Obwegeser JA. Maxillary and midface deformities: characteristics and treatment strategies. Clin Plast Surg. 2007 Jul;34(3):519-33.

Ohrbach R, editor. Diagnostic Criteria for Temporomandibular Disorders: Assessment Instruments. Version 15May2016. www.rdc-tmdinternational.org Accessed on June 5, 2020.

Orloff, G, Hale, LTCR. Mandibular osteotomies in orthognathic surgery. Journal of Craniofacial Surgery, v. 18, n. 4, p. 931-938, 2007.

Ozdemir, R, Baran, CN, Karagoz, MA, Dogan, S. Place of sagittal split osteotomy in mandibular surgery: Journal of Craniofacial Surgery, v. 20, n. 2, p. 349-355, 2009.

Parsi GK, Alsulaiman AA, Kotak B, Mehra P, Will LA, Motro M. Volumetric changes of the upper airway following maxillary and mandibular advancement using cone beam computed tomography. Int J Oral Maxillofac Surg. 2019 Feb;48(2):203-210.

Pellby D, Bengtsson M. Changes in the upper airway volume after orthognathic surgery: three-dimensional measurements in a supine body position. Int J Oral Maxillofac Surg. 2023 Sep;52(9):948-955.

Pinheiro ML, Yatabe M, Ioshida M, Orlandi L, Dumast P, Trindade-Suedam IK. Volumetric reconstruction and determination of minimum crosssectional area of the pharynx in patients with cleft lip and palate: comparison between two different softwares. J Appl Oral Sci. 2018 Oct 4;26:e20170282.

Proffit WR, Fields HW Jr, Moray LJ. Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey. Int J Adult Orthodon Orthognath Surg. 1998;13(2):97-106.

Raffaini M, Pisani C. Clinical and cone-beam computed tomography evaluation of the three-dimensional increase in pharyngeal airway space following maxillo-mandibular rotation-advancement for Class II correction in patients without sleep apnoea (OSA). J Craniomaxillofac Surg. 2013 Oct;41(7):552-7.

Ravelo V, Olate G, de Moraes M, Huentequeo C, Sacco R, Olate S. Condylar positional changes in skeletal class II and class III malocclusions after bimaxillary orthognathic surgery. *Journal of Personalized Medicine*. 2023; 13(11):1544.

Ravelo V, Olate G, Unibazo A, de Moraes M, Olate S. Retrospective Analysis of the Airway Space Changes in Dentofacial Deformity after Two-Jaw Orthognathic Surgery Using Cone Beam Computed Tomography. J Pers Med. 2023 Aug 14;13(8):1256.

Reyneke JP, Evans WG. Surgical manipulation of the occlusal plane. Int J Adult Orthodon Orthognath Surg. 1990;5(2):99-110.

Reyneke JP. Surgical cephalometric prediction tracing for the alteration of the occlusal plane by means of rotation of the maxillomandibular complex. Int J Adult Orthodon Orthognath Surg. 1999;14(1):55-64.

Reyneke JP. Surgical manipulation of the occlusal plane: new concepts in geometry. Int J Adult Orthodon Orthognath Surg. 1998;13(4):307-16.

Salazar AG, AlSulaiman A, Parsi G, Gunson M, Will LA, Motro M. Effects of counterclockwise bimaxillary advancement surgery and relapse on upper airway. Orthod Craniofac Res. 2023 Aug;26(3):510-523.

Schlueter B, Kim KB, Oliver D, Sortiropoulos G. Cone beam computed tomography 3D reconstruction of the mandibular condyle. Angle Orthod. 2008 Sep;78(5):880-8.

Sebastiani AM, Baratto-Filho F, Bonotto D, Kluppel LE, Rebellato NL, da Costa DJ, Scariot R. Influence of orthognathic surgery for symptoms of temporomandibular dysfunction. Oral Surg Oral Med Oral Pathol Oral Radiol. 2016 Feb;121(2):119-25.

Sebastiani AM, de Lucas Corso PFC, Bonotto D, de Souza JF, da Costa DJ, Scariot R, Rebellato NLB. Does orthognathic surgery improve myofacial pain in individuals with skeletal class III? One-year follow-up. Oral Surg Oral Med Oral Pathol Oral Radiol. 2018 Oct;126(4):322-330.

Shin JH, Kim MA, Park IY, Park YH. A 2-year follow-up of changes after bimaxillary surgery in patients with mandibular prognathism: 3-dimensional analysis of pharyngeal airway volume and hyoid bone position. J Oral Maxillofac Surg. 2015 Feb;73(2):340.e1-9.

Shujaat S, Shaheen E, Riaz M, Politis C, Jacobs R. Three-Dimensional Pharyngeal Airway Space Changes Following Isolated Mandibular Advancement Surgery in 120 Patients: A 1-Year Follow-up Study. J Imaging. 2022 Mar 22;8(4):82.

Steegman R, Hogeveen F, Schoeman A, Ren Y. Cone beam computed tomography volumetric airway changes after orthognathic surgery: a systematic review. Int J Oral Maxillofac Surg. 2023 Jan;52(1):60-71.

Takahara N, Tomomatsu N, Kimura A, Kosugi M, Kurasawa Y, Morita KI, Yoda T. Changes in the condylar volume and skeletal relapse following orthognathic surgery in patients with dentofacial deformity: A retrospective study. Cranio. 2022 May 4:1-11.

Trevisiol L, Bersani M, Sanna G, Nocini R, D'Agostino A. Posterior airways and orthognathic surgery: What really matters for successful long-term results? Am J Orthod Dentofacial Orthop. 2022 May;161(5):e486-e497.

Uetanabaro LC, Gerber JT, Dos Santos KM, Meger MN, da Costa DJ, Küchler EC, Sebastiani AM, Scariot R. Prevalence and associated factors of myofascial pain in orthognathic patients with skeletal class II malocclusion. Oral Maxillofac Surg. 2023 Mar;27(1):25-31.

Valls-Ontañón A, Giralt-Hernando M, Zamora-Almeida G, Anitua E, Mazarro-Campos A, Hernández-Alfaro F. Does orthognathic surgery have an incidentally beneficial effect on mild or asymptomatic sleep apnoea? Int J Oral Maxillofac Surg. 2023 Dec;52(12):1255-1261.

Vijayakumar Jain S, Muthusekhar MR, Baig MF, Senthilnathan P, Loganathan S, Abdul Wahab PU, Madhulakshmi M, Vohra Y. Evaluation of Three-Dimensional Changes in Pharyngeal Airway Following Isolated Lefort One Osteotomy for the Correction of Vertical Maxillary Excess: A Prospective Study. J Maxillofac Oral Surg. 2019 Mar;18(1):139-146.

Wan Z, Shen SG, Gui H, Zhang P, Shen S. Evaluation of the postoperative stability of a counterclockwise rotation technique for skeletal class II patients by using a novel three- dimensional position-posture method. Sci Rep. 2019;9(1):13196.

Wang Z, Shi Y, Wang Y, Chen W, Jiang H, Cheng J. Three-dimensional quantitative changes of condyle in patients with skeletal class III malocclusion after bimaxillary orthognathic surgery with 5-year follow-up. Clin Oral Investig. 2023 Jul;27(7):4061-4071.

Wolford LM, Chemello PD, Hilliard F. Occlusal plane alteration in orthognathic surgery-Part I: Effects on function and esthetics. Am J Orthod Dentofacial Orthop. 1994 Sep;106(3):304-16.

Wolford LM, Chemello PD, Hilliard FW. Occlusal plane alteration in orthognathic surgery. J Oral Maxillofac Surg. 1993 Jul;51(7):730-40; discussion 740-1.

Yang HJ, Jung YE, Kwon IJ, Lee JY, Hwang SJ. Airway changes and prevalence of obstructive sleep apnoea after bimaxillary orthognathic surgery with large mandibular setback. Int J Oral Maxillofac Surg. 2020 Mar;49(3):342-349.

Yong CW, Quah B, Ng WH, Lai WMC, Sim YF, Wong RCW. Maxillary Impaction Does Not Negatively Affect the Nasal Airway: A Systematic Review With Meta-Analysis. J Oral Maxillofac Surg. 2023 Oct;81(10):1227-1243.

Zere E, Chaudhari PK, Sharan J, Dhingra K, Tiwari N. Developing Class III malocclusions: challenges and solutions. Clin Cosmet Investig Dent. 2018 Jun 22;10:99-116.

Zhang Z, Wang S, Li J, Yang Z, Zhang X, Bai X. Quantification of pharyngeal airway space changes after two-jaw orthognathic surgery in skeletal class III patients. BMC Oral Health. 2023 Jun 1;23(1):345.

7 APÊNDICES

7.1 APÊNDICE 1 (APPENDIX 1). TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO - TCLE

Nós, **Rafaela Scariot, Fábio Marzullo Zaroni e Nelson Luis Barbosa Rebellato** – pesquisadores do Programa de Pós Graduação em Odontologia da Universidade Federal do Paraná – UFPR estamos convidando você, paciente do serviço de Cirurgia e Traumatologia Bucomaxilofacial (CTBMF) da UFPR a participar de um estudo intitulado **"Fatores associados a estabilidade das alterações no plano oclusal em pacientes submetidos a cirurgia ortognática"**, cuja justificativa consiste em aprimorar o serviço prestado e a qualidade dos resultados.

a) Avaliar a estabilidade das modificações da posição dos ossos da maxila e da mandíbula após a realização de cirurgia ortognática.

b) Caso você participe da pesquisa, será necessário passar por uma avaliação inicial, com coletas de dados pessoais e aplicação de questionários para avaliação de desordens da articulação temporomandibular, antes e após o procedimento a ser realizado. Também será realizada coleta de amostra de saliva e raspagem de células bucais para avaliar características genéticas relacionadas à função dos ossos.

c) Para tanto você deverá comparecer nas dependências das clínicas Odontológicas da UFPR - Serviço de Cirurgia e Traumatologia Bucomaxilofacial localizado na Avenida Pref. Lothário Meissner, CEP 80210-70, Jardim Botânico – Curitiba/PR, quatro vezes, para consultas odontológicas, exames clínicos, exames radiológicos, coleta de saliva e células da boca, além de preenchimento de questionário que conterá as informações necessárias para este estudo, o que levará cerca de 30 minutos para cada etapa da pesquisa. Você comparecerá a estas consultas por necessidade dos controles pré e pós-operatórios preconizados para este tipo de tratamento e não são exclusivas para a pesquisa. Os retornos serão agendados conforme os cuidados necessários para este tipo de cirurgia.

d) É possível que você experimente algum desconforto, principalmente relacionado a cansaço devido às várias etapas da pesquisa.

e) Alguns riscos relacionados ao estudo podem ser indiretos, como constrangimentos durante a coleta de dados, outros riscos podem ser direto, como leve desconforto na raspagem de células bucais após a coleta de saliva. Devido esse fato, as entrevistas se darão em um ambiente adequado e particular, e em caso de desconforto será opção do paciente continuar ou não com a pesquisa, sendo as informações restritas somente à pesquisadora principal da pesquisa.

f) Os benefícios esperados com essa pesquisa estão relacionados a identificação de possíveis variáveis associadas com a estabilidade das modificações ósseas realizadas por meio de cirurgia ortognática. Consequentemente, poderemos aprimorar o atendimento odontológico prestado a comunidade, embora nem sempre você seja diretamente beneficiado por sua participação neste estudo.

g) Os pesquisadores Rafaela Scariot, Fábio Marzullo Zaroni e Nelson Luis Barbosa Rebellato, responsáveis por este estudo poderão ser localizados no bloco do Curso de Odontologia da UFPR localizado na Avenida Pref. Lothário Meissner, CEP 80210-70, Jardim Botânico – Curitiba/PR ou através do telefone (41) 3360-4053, nas terças e quintas-feiras das 13h30min às 17h, na sala da Pós-graduação em Cirurgia Bucomaxilofacial, ou através dos e-mails fabiomarzaroni@gmail.com, rafaela_scariot@yahoo.com.br e nelsonrebellato@hotmail.com, para esclarecer eventuais dúvidas que você possa ter e fornecer-lhe as informações que queira, antes, durante ou depois de encerrado o estudo. Também estão disponíveis os telefones dos pesquisadores Fábio Marzullo Zaroni (99642-3942), Rafaela Scariot (99144-8815) e Nelson Luis Barbosa Rebelltato (99127-8058).

Rubricas:
- Participante da Pesquisa e/ou Responsável Legal: ________________________________
- Pesquisador Responsável pela aplicação do TCLE: ________________________________
- Professor Orientador: __________________________

h) A sua participação neste estudo é voluntária e se você não quiser mais fazer parte da pesquisa poderá desistir a qualquer momento e solicitar que lhe devolvam este Termo de Consentimento Livre e Esclarecido assinado. Ainda, não terá prejuízo em seu atendimento em caso de desistência.

As informações relacionadas ao estudo poderão ser conhecidas por pessoas autorizadas. No entanto, se qualquer informação for divulgada em relatório ou publicação, isto será feito sob forma codificada, para que a sua identidade seja preservada e mantida sua confidencialidade.

i) O material obtido – amostras biológicas, questionários – será utilizado unicamente para essa pesquisa e será destruído/descartado ao término do estudo, dentro de 3 anos.

j) As despesas necessárias para a realização da pesquisa (materiais a serem utilizados como papéis ou aparelhos) não são de sua responsabilidade. Caso necessário deslocamento exclusivo para participar da pesquisa, você receberá ressarcimento para despesas de transporte.

k) Quando os resultados forem publicados, não aparecerá seu nome, e sim um código.

l) Se você tiver dúvidas sobre seus direitos como participante de pesquisa, você pode contatar também o Comitê de Ética em Pesquisa em Seres Humanos (CEP/SD) do Setor de Ciências da Saúde da Universidade Federal do Paraná, pelo telefone 3360-7259. O Comitê de Ética em Pesquisa é um órgão colegiado multi e transdisciplinar, independente, que existe nas instituições que realizam pesquisa envolvendo seres humanos no Brasil e foi criado com o objetivo de proteger os participantes de pesquisa, em sua integridade e dignidade, e assegurar que as pesquisas sejam desenvolvidas dentro de padrões éticos (Resolução nº 466/12 Conselho Nacional de Saúde).

m) Autorizo ( ), não autorizo ( ), o uso de meus dados coletados para fins da pesquisa, sendo seu uso restrito a trabalhos acadêmicos e científicos.

Eu,____li esse Termo de Consentimento e compreendi a natureza e objetivo do estudo do qual concordei em participar. A explicação que recebi menciona os riscos e benefícios. Eu entendi que sou livre para interromper minha participação a qualquer momento sem justificar minha decisão e sem qualquer prejuízo para mim e sem que esta decisão afete meu tratamento.

Eu concordo voluntariamente em participar deste estudo.

Curitiba,_________de_________________de ________

____
Assinatura do Participante de
Pesquisa ou Responsável Legal

____
Assinatura do Pesquisador Responsável
pela aplicação do TCLE

7.2 APÊNDICE 2 (APPENDIX 2). PARECER CONSUBSTANCIADO DO CEP

UFPR - SETOR DE CIÊNCIAS DA SAÚDE DA UNIVERSIDADE FEDERAL DO PARANÁ - SCS/UFPR

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Fatores associados a estabilidade das alterações no plano oclusal em pacientes submetidos a cirurgia ortognática

Pesquisador: Rafaela Scariot

Área Temática: Genética Humana:
(Trata-se de pesquisa envolvendo Genética Humana que não necessita de análise ética por parte da CONEP;);

Versão: 2

CAAE: 38392920.2.0000.0102

Instituição Proponente: Departamento de Estomatologia

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 4.442.714

Apresentação do Projeto:

Trata-se de respostas as pendencias do protocolo de pesquisa intitulado : Fatores associados a estabilidade das alterações no plano oclusal em pacientes submetidos a cirurgia ortognática
Pesquisador responsável: Rafaela Scariot
Colaborador: Fabio Marzullo Zaroni , Nelson Luis Barbosa Rebellato
Instituição Proponente: Departamento de Estomatologia
Período da Pesquisa: A partir da aprovação no comitê de ética em pesquisa até dezembro de 2023
Local de realização da pesquisa: Serviço de Cirurgia e Traumatologia Bucomaxilofacial, no Departamento de Estomatologia da Universidade Federal do Paraná

Objetivo da Pesquisa:

Avaliar a estabilidade das alterações realizadas no plano oclusal (PO) por meio de cirurgia ortognática em pacientes com deformidade dentofacial

Avaliação dos Riscos e Benefícios:

De acordo com os pesquisadores:

Endereço: Rua Padre Camargo, 285 - 1º andar
Bairro: Alto da Glória **CEP:** 80.060-240
UF: PR **Município:** CURITIBA
Telefone: (41)3360-7259 **E-mail:** cometica.saude@ufpr.br

Riscos:
Os riscos que a pesquisa pode apresentar é uma possível quebra de confidencialidade (muitas vezes devido ao local onde serão aplicados os questionários) e também constrangimento do paciente (devido a perguntas pessoais que muitas vezes para ele não sejam necessárias, contudo, para a pesquisa se tornam importantes, além de existir a possibilidade do paciente sentir um leve desconforto durante a coleta da saliva, no momento da raspagem da mucosa jugal para coleta das células bucais). Os dados dos participantes terão sigilo e somente os pesquisadores diretamente envolvidos na pesquisa terão acesso ao dados coletados.
Benefícios:
Os benefícios agregados à pesquisa estão vinculados ao aprimoramento do tratamento de pacientes submetidos a cirurgia ortognática para correção de deformidades dentocaciais e má oclusões esqueléticas. O estudo visa preencher lacunas no conhecimento em relação às repercussões e estabilidade da modificações espaciais do plano oclusal em indivíduos submetidos a este tipo de procedimento cirúrgico

Comentários e Considerações sobre a Pesquisa:
Foram atendidas as pendências e inadequações:
1) No documento informações básicas no projeto foram preenchidos os campos desenho do estudo e resumo do estudo;

2) No Projeto de pesquisa detalhado (PÁGINA 03) foi reescrito o resumo do estudo (o resumo não está mais escrito como introdução do projeto);

3) No documento informações básicas no projeto foram preenchidos os Objetivos Específicos do projeto;

4) No projeto de pesquisa detalhado o item 4. Antecedentes científicos e seus subitens (PÁGINAS 06 a 12) foram reescritos, melhorando o referencial teórico para dar suporte os objetivos propostos do estudo. Novos artigos foram adicionados para referenciar as informações adicionadas;

5) No projeto de pesquisa detalhado o item 5. Casuística (PÁGINA 13) foi reescrito;

6) Em todo o Projeto de pesquisa, o plano para o Recrutamento do Participante da Pesquisa, bem como a forma de abordagem foi revisto em todo projeto de acordo com a Resolução 466/12 (PÁGINAS 14 e 27);

7) No Projeto de pesquisa detalhado no item 6 material e metodologia (PÁGINA 15), foi adicionado o item 6.3 Cálculo amostral onde foi explicado como foi realizado o cálculo amostral, considerando o nº de participantes da pesquisa=100, que foi apresentado no documento informações básicas do projeto. Ainda adicionamos uma explicação da necessidade de refazer este cálculo amostral devido a restrições causadas pela pandemia de COVID-19.

8) No Projeto de pesquisa detalhado no item 6 material e metodologia (PÁGINA 15): Foi criado o item 6.4 Etapas da Pesquisa e descrito as etapas do estudo, quantas vezes o participante de pesquisa deverá comparecer ao serviço (atendimento), quando e como serão realizadas as coletas de material biológico para exame genético, quando serão realizados os exames de imagem e a duração aproximada de cada um destes momentos;

9) No Projeto de pesquisa detalhado no item 6 material e metodologia: no item 6.8 Amostra de DNA (saliva e células epiteliais da mucosa bucal) (PÁGINA 17) foi descrito os passos após realizada as coletas das amostras de saliva e células da mucosa bucal para avaliação dos polimorfismos genéticos bem como o local onde serão realizadas as análises;

10) No documento informações básicas no projeto, o item Riscos foi reescrito, de acordo com a Resolução 466/12, considerando a maneira como estes riscos podem ser evitados e minimizados;

11) No documento informações básicas no projeto no item Benefícios, foi preenchido quais os benefícios diretos aos participantes de pesquisa;

12) No Projeto de pesquisa detalhado no item 20. (PÁGINA 29) A previsão de ressarcimento de gastos aos participantes da pesquisa foi revista caso haja necessidade do participante de pesquisa necessite se deslocar exclusivamente para participar da pesquisa. Adicionamos a informação de

que o projeto irá atender a resolução 466/12, prevendo o ressarcimento quanto ao gasto com o deslocamento;

13) No TCLE substituímos os termos técnicos por linguagem simples, clara e objetiva (PÁGINA 01);

14) No TCLE no item "c)" (PÁGINA 01), esclarecemos quantas vezes o participante deverá retornar e também os tipos de exames que serão realizados, bem como uma previsão de tempo para cada etapa da pesquisa;

15) No TCLE, no item g) (PÁGINA 01) foram adicionados os telefones de contato dos pesquisadores para acesso fácil.

16) No TCLE o item j) (PÁGINA 02) foi revisto e reescrito levando em conta a resolução 466/12, prevendo o ressarcimento quanto ao gasto com o deslocamento caso o participante da pesquisa tenha que fazer qualquer deslocamento exclusivo para participar da pesquisa.

17) Foram anexadas as cartas de concordância dos serviços envolvidos: Serviço do Laboratório de Ensino e Pesquisa de Imaginologia da UFPR (LABIM) e Laboratório de Polimorfismos e Ligação do Departamento de Genética da UFPR.

Considerações sobre os Termos de apresentação obrigatória:

Foram anexadas as cartas de concordância dos serviços envolvidos: Serviço do Laboratório de Ensino e Pesquisa de Imaginologia da UFPR (LABIM) e Laboratório de Polimorfismos e Ligação do Departamento de Genética da UFPR.

Recomendações:

não há

Conclusões ou Pendências e Lista de Inadequações:

Todas as pendências foram atendidas , aprovado.

Favor inserir em seu TCLE e TALE o número do CAAE e o número do Parecer de aprovação, para

que possa aplicar aos participantes de sua pesquisa, conforme decisão da Coordenação do CEP/SD de 13 de julho de 2020.
Após o isolamento, retornaremos à obrigatoriedade do carimbo e assinatura nos termos.
Qualquer dúvida, retornar e-mail ou pelo WhatsApp 41-3360-7259.

Considerações Finais a critério do CEP:
Solicitamos que sejam apresentados a este CEP, relatórios semestrais e final, sobre o andamento da pesquisa, bem como informações relativas às modificações do protocolo, cancelamento, encerramento e destino dos conhecimentos obtidos, através da Plataforma Brasil - no modo: NOTIFICAÇÃO. Demais alterações e prorrogação de prazo devem ser enviadas no modo EMENDA. Lembrando que o cronograma de execução da pesquisa deve ser atualizado no sistema Plataforma Brasil antes de enviar solicitação de prorrogação de prazo.
Emenda – ver modelo de carta em nossa página: www.cometica.ufpr.br (obrigatório envio)

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1619978.pdf	25/11/2020 13:10:14		Aceito
Outros	Relatorio_resolucao_de_pendencias_CEP.doc	25/11/2020 13:08:19	Fabio Marzullo Zaroni	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_CORRIGIDO.doc	25/11/2020 13:06:35	Fabio Marzullo Zaroni	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_de_Pesquisa_CORRIGIDO.docx	25/11/2020 13:06:00	Fabio Marzullo Zaroni	Aceito
Outros	Concordancia_dos_servicos_envolvidos_genetica.pdf	24/11/2020 10:44:07	Fabio Marzullo Zaroni	Aceito
Outros	Concordancia_dos_servicos_envolvidos_LABIM.pdf	01/11/2020 12:39:18	Fabio Marzullo Zaroni	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE.doc	18/09/2020 14:15:28	Fabio Marzullo Zaroni	Aceito

Outros	Analise_do_merito_cientifico.pdf	18/09/2020 13:54:58	Fabio Marzullo Zaroni	Aceito
Outros	Carta_de_encaminhamento_do_pesquisador_ao_CEP.pdf	18/09/2020 13:52:47	Fabio Marzullo Zaroni	Aceito
Declaração de Pesquisadores	Declaracao_de_Compromissos_da_Equipe_de_Pesquisa.pdf	18/09/2020 13:51:21	Fabio Marzullo Zaroni	Aceito
Outros	Termo_de_Guarda_de_Material_Biologico.pdf	18/09/2020 13:49:10	Fabio Marzullo Zaroni	Aceito
Outros	Extrato_da_ata_de_aprovacao_do_projeto.pdf	17/09/2020 13:32:29	Fabio Marzullo Zaroni	Aceito
Outros	Check_List_Documental.pdf	17/09/2020 13:03:31	Fabio Marzullo Zaroni	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_de_Pesquisa.docx	17/09/2020 13:01:00	Fabio Marzullo Zaroni	Aceito
Folha de Rosto	Folha_de_Rosto.pdf	17/09/2020 09:33:38	Fabio Marzullo Zaroni	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

CURITIBA, 07 de Dezembro de 2020

Assinado por:
IDA CRISTINA GUBERT
(Coordenador(a))

Endereço: Rua Padre Camargo, 285 - 1º andar
Bairro: Alto da Glória **CEP:** 80.060-240
UF: PR **Município:** CURITIBA
Telefone: (41)3360-7259 **E-mail:** cometica.saude@ufpr.br

8 ANEXOS

8.1 ANEXO 1 (ANNEX 1). DC/TMD FORM, QUESTIONNAIRES AND DIAGNOSTIC DECISION TREE

DC/TMD Examination Form

Date filled out (mm-dd-yyyy) ___-___-_____

Patient ____________________ Examiner ____________________

1a. Location of Pain: Last 30 days (Select all that apply)

RIGHT PAIN	LEFT PAIN
O None O Temporalis O Masseter O Other m muscles O TMJ O Non-mast structures	O None O Temporalis O Masseter O Other m muscles O TMJ O Non-mast structures

1b. Location of Headache: Last 30 days (Select all that apply)

Right	Left
O None O Temporal O Other	O None O Temporal O Other

2. Incisal Relationships **Reference tooth** O **FDI #11** O **FDI #21** O **Other**

Horizontal Incisal Overjet O If negative [ ][ ] mm

Vertical Incisal Overlap O If negative [ ][ ] mm

Midline Deviation: Right O Left O N/A O [ ][ ] mm

3. Opening Pattern (Supplemental; Select all that apply)

O Straight O Corrected deviation

Uncorrected Deviation: O Right O Left

4. Opening Movements

A. Pain Free Opening [ ][ ] mm

B. Maximum Unassisted Opening [ ][ ] mm

	RIGHT SIDE			LEFT SIDE		
	Pain	Familiar Pain	Familiar Headache	Pain	Familiar Pain	Familiar Headache
Temporalis	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Masseter	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
TMJ	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Other M Musc	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Non-mast	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	

C. Maximum Assisted Opening [ ][ ] mm

	RIGHT SIDE			LEFT SIDE		
	Pain	Familiar Pain	Familiar Headache	Pain	Familiar Pain	Familiar Headache
Temporalis	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Masseter	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
TMJ	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Other M Musc	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Non-mast	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	

D. Terminated? Ⓝ Ⓨ

5. Lateral and Protrusive Movements

A. Right Lateral [ ][ ] mm

	RIGHT SIDE			LEFT SIDE		
	Pain	Familiar Pain	Familiar Headache	Pain	Familiar Pain	Familiar Headache
Temporalis	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Masseter	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
TMJ	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Other M Musc	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Non-mast	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	

B. Left Lateral [ ][ ] mm

	RIGHT SIDE			LEFT SIDE		
	Pain	Familiar Pain	Familiar Headache	Pain	Familiar Pain	Familiar Headache
Temporalis	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Masseter	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
TMJ	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Other M Musc	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Non-mast	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	

C. Protrusion [ ][ ] mm

O If negative

	RIGHT SIDE			LEFT SIDE		
	Pain	Familiar Pain	Familiar Headache	Pain	Familiar Pain	Familiar Headache
Temporalis	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Masseter	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
TMJ	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Other M Musc	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	
Non-mast	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ	Ⓝ Ⓨ	

6. TMJ Noises During Open & Close Movements

RIGHT TMJ	Examiner Open	Examiner Close	Patient	Pain w/ Click	Familiar Pain
Click	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ →	Ⓝ Ⓨ	Ⓝ Ⓨ
Crepitus	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ		

LEFT TMJ	Examiner Open	Examiner Close	Patient	Pain w/ Click	Familiar Pain
Click	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ →	Ⓝ Ⓨ	Ⓝ Ⓨ
Crepitus	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ		

7. TMJ Noises During Lateral & Protrusive Movements

RIGHT TMJ	Examiner	Patient	Pain w/ Click	Familiar Pain
Click	Ⓝ Ⓨ	Ⓝ Ⓨ →	Ⓝ Ⓨ	Ⓝ Ⓨ
Crepitus	Ⓝ Ⓨ	Ⓝ Ⓨ		

LEFT TMJ	Examiner	Patient	Pain w/ Click	Familiar Pain
Click	Ⓝ Ⓨ	Ⓝ Ⓨ →	Ⓝ Ⓨ	Ⓝ Ⓨ
Crepitus	Ⓝ Ⓨ	Ⓝ Ⓨ		

8. Joint Locking

RIGHT TMJ	Locking	Reduction Patient	Reduction Examiner
While Opening	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Wide Open Position	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ

LEFT TMJ	Locking	Reduction Patient	Reduction Examiner
While Opening	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Wide Open Position	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ

9. Muscle & TMJ Pain with Palpation

RIGHT SIDE (1 kg)	Pain	Familiar Pain	Familiar Headache	Referred Pain
Temporalis (posterior)	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Temporalis (middle)	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Temporalis (anterior)	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Masseter (origin)	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ
Masseter (body)	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ
Masseter (insertion)	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ

LEFT SIDE (1 kg)	Pain	Familiar Pain	Familiar Headache	Referred Pain
Temporalis (posterior)	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Temporalis (middle)	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Temporalis (anterior)	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Masseter (origin)	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ
Masseter (body)	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ
Masseter (insertion)	Ⓝ Ⓨ	Ⓝ Ⓨ		Ⓝ Ⓨ

RIGHT SIDE TMJ	Pain	Familiar Pain	Referred Pain
Lateral pole **(0.5 kg)**	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Around lateral pole **(1 kg)**	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ

LEFT SIDE TMJ	Pain	Familiar Pain	Referred Pain
Lateral pole **(0.5 kg)**	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Around lateral pole **(1 kg)**	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ

10. Supplemental Muscle Pain with Palpation

RIGHT SIDE (0.5 kg)	Pain	Familiar Pain	Referred Pain
Posterior mandibular region	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Submandibular region	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Lateral pterygoid area	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Temporalis tendon	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ

LEFT SIDE (0.5 kg)	Pain	Familiar Pain	Referred Pain
Posterior mandibular region	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Submandibular region	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Lateral pterygoid area	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ
Temporalis tendon	Ⓝ Ⓨ	Ⓝ Ⓨ	Ⓝ Ⓨ

11. Diagnoses

Pain Disorders

- ○ None
- ○ Myalgia
- ○ Myofascial pain with referral
- ○ Right Arthralgia
- ○ Left Arthralgia
- ○ Headache attributed to TMD

Right TMJ Disorders

- ○ None
- Disc displacement (select one)
- ○ ...with reduction
- ○ ...with reduction, with intermittent locking
- ○ ... without reduction, with limited opening
- ○ ... without reduction, without limited opening
- ○ Degenerative joint disease
- ○ Subluxation

Left TMJ Disorders

- ○ None
- Disc displacement (select one)
- ○ ...with reduction
- ○ ...with reduction, with intermittent locking
- ○ ... without reduction, with limited opening
- ○ ... without reduction, without limited opening
- ○ Degenerative joint disease
- ○ Subluxation

12. Comments

Diagnostic Criteria for Temporomandibular Disorders

Symptom Questionnaire

Patient name ______________________________ Date ____________________

PAIN

		No	Yes
1.	Have you ever had pain in your jaw, temple, in the ear, or in front of the ear on either side?	☐	☐

If you answered NO, then skip to Question 5.

2.	How many years or months ago did your pain in the jaw, temple, in the ear, or in front of the ear first begin?	_______years	______months

3. In the last 30 days, which of the following best describes any pain in your jaw, temple, in the ear, or in front of the ear on either side?

Select ONE response.

- ☐ No pain
- ☐ Pain comes and goes
- ☐ Pain is always present

If you answered NO to Question 3, then skip to Question 5.

4. In the last 30 days, did the following activities change any pain (that is, make it better or make it worse) in your jaw, temple, in the ear, or in front of the ear on either side?

		No	Yes
A.	Chewing hard or tough food	☐	☐
B.	Opening your mouth, or moving your jaw forward or to the side	☐	☐
C.	Jaw habits such as holding teeth together, clenching/grinding teeth, or chewing gum	☐	☐
D.	Other jaw activities such as talking, kissing, or yawning	☐	☐

HEADACHE

		No	Yes
5.	In the last 30 days, have you had any headaches that included the temple areas of your head?	☐	☐

If you answered NO to Question 5, then skip to Question 8.

6.	How many years or months ago did your temple headache first begin?	_______years	______months

7. In the last 30 days, did the following activities change any headache (that is, make it better or make it worse) in your temple area on either side?

		No	Yes
A.	Chewing hard or tough food	☐	☐
B.	Opening your mouth, or moving your jaw forward or to the side	☐	☐
C.	Jaw habits such as holding teeth together, clenching/grinding, or chewing gum	☐	☐
D.	Other jaw activities such as talking, kissing, or yawning	☐	☐

JAW JOINT NOISES				Office use		
8.	In the last 30 days, have you had any jaw joint noise(s) when you moved or used your jaw?	No ☐	Yes ☐	R ☐	L ☐	DNK ☐
CLOSED LOCKING OF THE JAW						
9.	Have you ever had your jaw lock or catch, even for a moment, so that it would not open ALL THE WAY? **If you answered NO to Question 9 then skip to Question 13.**	☐	☐	☐	☐	☐
10.	Was your jaw lock or catch severe enough to limit your jaw opening and interfere with your ability to eat?	☐	☐	☐	☐	☐
11.	In the last 30 days, did your jaw lock so you could not open ALL THE WAY, even for a moment, and then unlock so you could open ALL THE WAY? **If you answered NO to Question 11 then skip to Question 13.**	☐	☐	☐	☐	☐
12.	Is your jaw currently locked or limited so that your jaw will not open ALL THE WAY?	☐	☐	☐	☐	☐
OPEN LOCKING OF THE JAW						
13.	In the last 30 days, when you opened your mouth wide, did your jaw lock or catch even for a moment such that you could not close it from this wide open position? **If you answered NO to Question 13 then you are finished.**	☐	☐	☐	☐	☐
14.	In the last 30 days, when you jaw locked or caught wide open, did you have to do something to get it to close including resting, moving, pushing, or maneuvering it?	☐	☐	☐	☐	☐

GAD - 7

Over the last 2 weeks, how often have you been bothered by the following problems? Place a check mark in the box to indicate your answer.

	Not at all	Several days	More than half the days	Nearly every day
	0	1	2	3
1. Feeling nervous, anxious or on edge	☐	☐	☐	☐
2. Not being able to stop or control worrying	☐	☐	☐	☐
3. Worrying too much about different things	☐	☐	☐	☐
4. Trouble relaxing	☐	☐	☐	☐
5. Being so restless that it is hard to sit still	☐	☐	☐	☐
6. Becoming easily annoyed or irritable	☐	☐	☐	☐
7. Feeling afraid as if something awful might happen	☐	☐	☐	☐
TOTAL SCORE =				

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all	Somewhat difficult	Very difficult	Extremely difficult
☐	☐	☐	☐

Patient Health Questionnaire-15: Physical Symptoms

During the last 4 weeks, how much have you have been bothered by any of the following problems? Please place a check mark in the box to indicate your answer.

		Not bothered 0	Bothered a little 1	Bothered a lot 2
1.	Stomach pain	☐	☐	☐
2.	Back pain	☐	☐	☐
3.	Pain in your arms, legs, or joints (knees, hips, etc)	☐	☐	☐
4.	Menstrual cramps or other problems with your periods [women only]	☐	☐	☐
5.	Headaches	☐	☐	☐
6.	Chest pain	☐	☐	☐
7.	Dizziness	☐	☐	☐
8.	Fainting spells	☐	☐	☐
9.	Feeling your heart pound or race	☐	☐	☐
10.	Shortness of breath	☐	☐	☐
11.	Pain or problems during sexual intercourse	☐	☐	☐
12.	Constipation, loose bowels, or diarrhea	☐	☐	☐
13.	Nausea, gas, or indigestion	☐	☐	☐
14.	Feeling tired or having low energy	☐	☐	☐
15.	Trouble sleeping	☐	☐	☐

TOTAL SCORE =

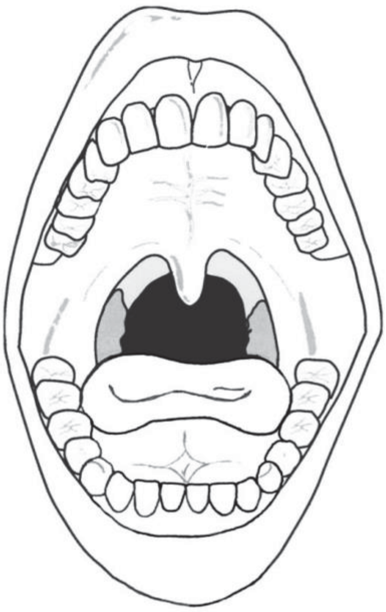
The Oral Behavior Checklist

How often do you do each of the following activities, based on **the last month**? If the frequency of the activity varies, choose the higher option. Please place a (√) response for each item and do not skip any items.

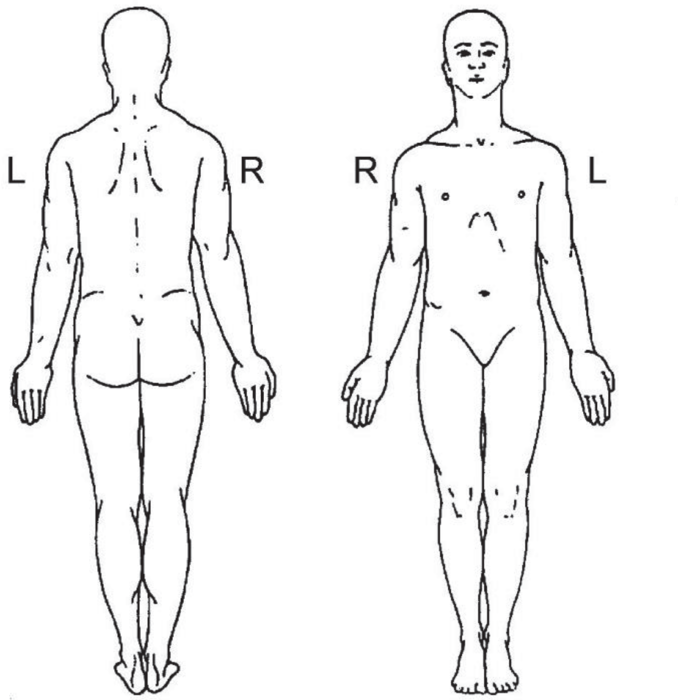
	Activities During Sleep	**None of the time**	**< 1 Night /Month**	**1-3 Nights /Month**	**1-3 Nights /Week**	**4-7 Nights/ Week**
1	Clench or grind teeth **when asleep**, based on any information you may have	☐	☐	☐	☐	☐
2	Sleep in a position that puts pressure on the jaw (for example, on stomach, on the side)	☐	☐	☐	☐	☐
	Activities During Waking Hours	**None of the time**	**A little of the time**	**Some of the time**	**Most of the time**	**All of the time**
3	Grind teeth together **during waking hours**	☐	☐	☐	☐	☐
4	Clench teeth together **during waking hours**	☐	☐	☐	☐	☐
5	Press, touch, or hold teeth together other than while eating (that is, contact between upper and lower teeth)	☐	☐	☐	☐	☐
6	Hold, tighten, or tense muscles without clenching or bringing teeth together	☐	☐	☐	☐	☐
7	Hold or jut jaw forward or to the side	☐	☐	☐	☐	☐
8	Press tongue forcibly against teeth	☐	☐	☐	☐	☐
9	Place tongue between teeth	☐	☐	☐	☐	☐
10	Bite, chew, or play with your tongue, cheeks or lips	☐	☐	☐	☐	☐
11	Hold jaw in rigid or tense position, such as to brace or protect the jaw	☐	☐	☐	☐	☐
12	Hold between the teeth or bite objects such as hair, pipe, pencil, pens, fingers, fingernails, etc	☐	☐	☐	☐	☐
13	Use chewing gum	☐	☐	☐	☐	☐
14	Play musical instrument that involves use of mouth or jaw (for example, woodwind, brass, string instruments)	☐	☐	☐	☐	☐
15	Lean with your hand on the jaw, such as cupping or resting the chin in the hand	☐	☐	☐	☐	☐
16	Chew food on one side only	☐	☐	☐	☐	☐
17	Eating between meals (that is, food that requires chewing)	☐	☐	☐	☐	☐
18	Sustained talking (for example, teaching, sales, customer service)	☐	☐	☐	☐	☐
19	Singing	☐	☐	☐	☐	☐
20	Yawning	☐	☐	☐	☐	☐
21	Hold telephone between your head and shoulders	☐	☐	☐	☐	☐

PAIN DRAWING

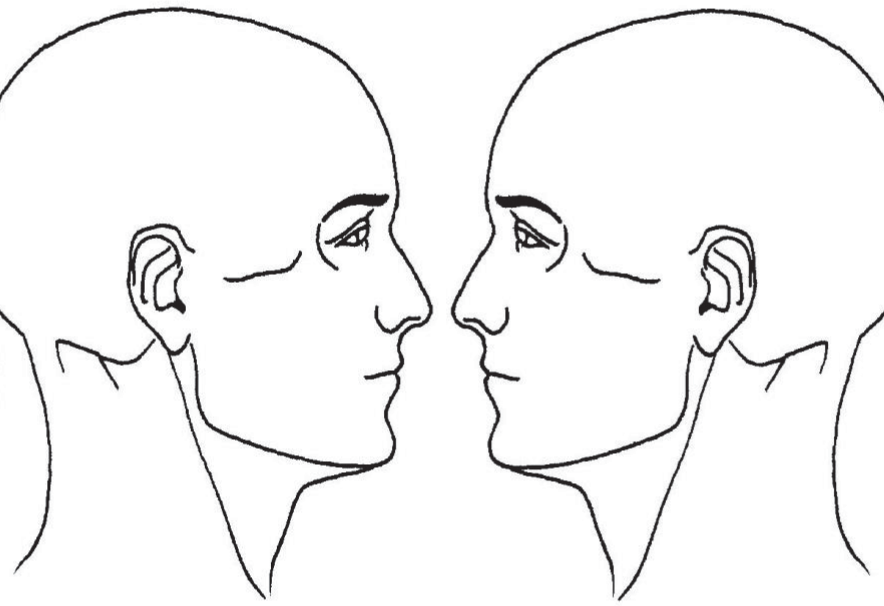
Indicate the location of ALL of your different pains by shading in the area, using the diagrams that are most relevant. If there is an exact spot where the pain is located, indicate with a solid dot (●). If your pain moves from one location to another, use arrows to show the path.



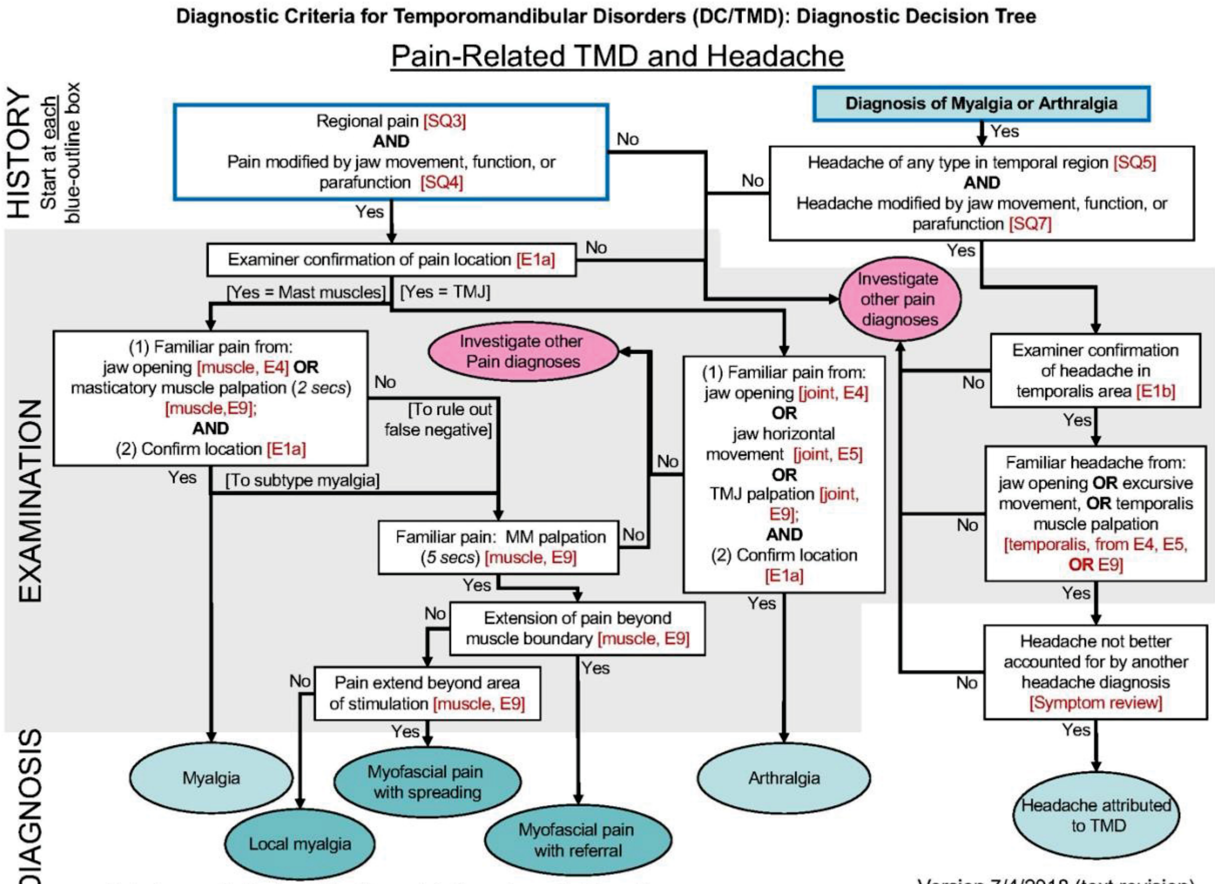
Mouth and teeth



Right face



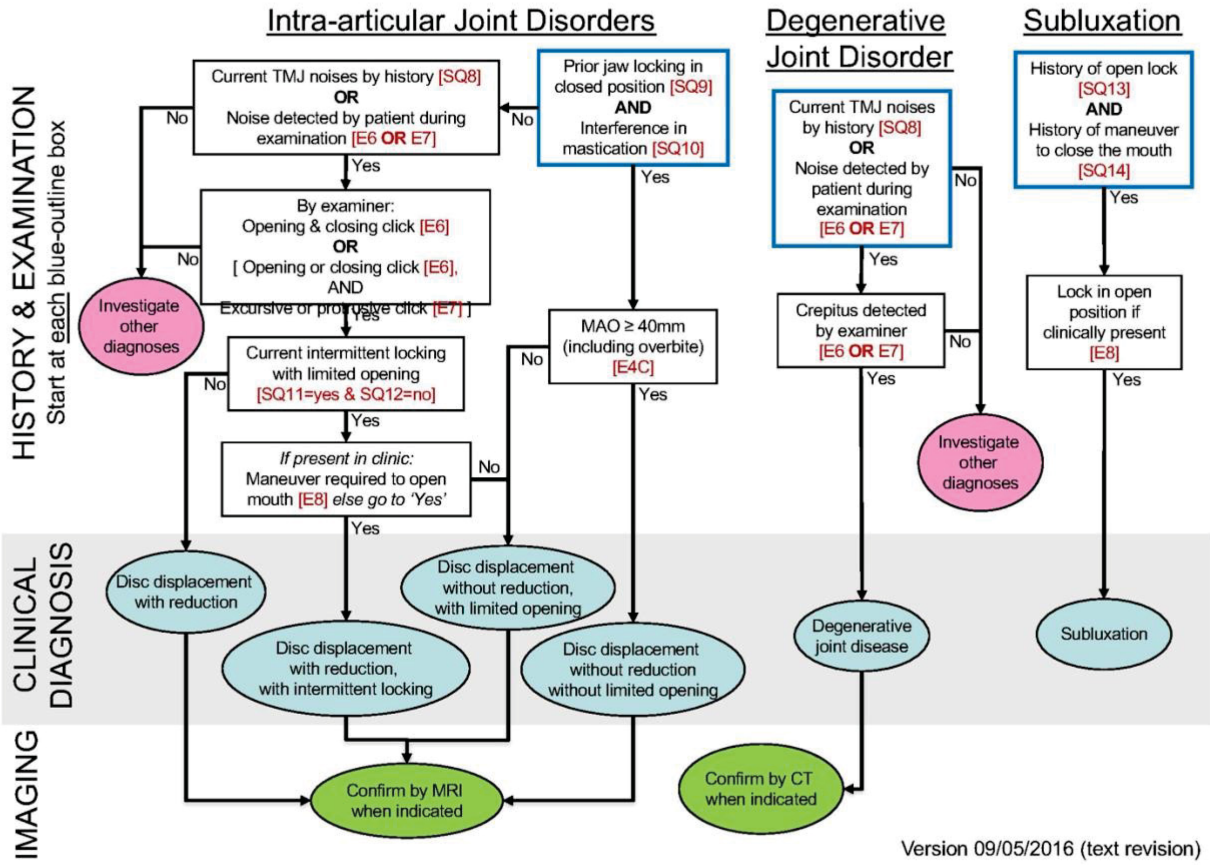
Left face



Note: 2 secs palpation is sufficient for myalgia; 5-secs is required for subtypes

Version 7/4/2018 (text revision)

Diagnostic Criteria for Temporomandibular Disorders (DC/TMD): Diagnostic Decision Tree



Version 09/05/2016 (text revision)

8.2 ANEXO 2 (ANNEX 2). NORMAS DA REVISTA PARA SUBMISSÃO

Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology

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GUIDE FOR AUTHORS

Section Scope Statements

The *Oral and Maxillofacial Surgery Section* aims to publish an extensive range of original articles that advances patient care through enhanced understanding of diagnosis, surgical and adjunctive treatment of diseases, and injuries and defects involving both the functional and esthetic aspects of the hard and soft tissues of the oral and maxillofacial regions. The section also seeks research regarding both the basic science of and management of persons with oral and maxillofacial conditions. Articles presenting ethical, original, well-documented, and reproducible research are given preference.

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- Final approval of the version to be published; AND
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