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Critérios de Diagnóstico para Pesquisa das Desordens Temporomandibulares (RDC/TMD): avaliação de radiologistas sobre adequação

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Critérios de Diagnóstico para Pesquisa das Desordens Temporomandibulares (RDC/TMD): avaliação de radiologistas sobre adequação

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Dedico este trabalho...

... aos meus pais, que me permitiram a oportunidade da vida

...a Sérgio, meu esposo e companheiro. Minha fortaleza!

... a todos os pacientes que sofrem com dores orofaciais

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SIGLAS E ABREVIATURAS

ATM	Articulação Temporomandibular
TMJ	Temporomandibular Joint
DTM	Desordens Temporomandibulares
TMD	Temporomandibular Disorders
DATM	Desordens da Articulação Temporomandibular
TMJD	Temporomandibular Joint Disorders
RM	Ressonânica Magnética
MRI / MR	Magnetic Resonance Image
TC	Tomografia Computadorizada
CT	Computed Tomography
TCFC	Tomografia Computadorizada por Feixe Cônico
CBCT	Cone Beam Computed Tomography
RDC/TMD	Critérios para Pesquisa das Desordens Temporomandibulares (Research Diagnostic Criteria for Temporomandibular Disorders)

RESUMO

O objetivo desse estudo foi investigar a opinião de especialistas em radiologia, de várias partes do mundo, quanto aos critérios propostos para aquisição e interpretação de imagens por Tomografia Computadorizada (TC), Tomografia Computadorizada por Feixe Cônico (TCFC) e Ressonância Magnética (RM) no diagnóstico das desordens da articulação temporomandibular (DATM) como parte dos Critérios de Diagnóstico para Pesquisa das Desordens Temporomandibulares (RDC/TMD). Especialistas em radiologia foram convidados por meio de e-mail a participar como voluntários do estudo a partir de três diferentes populações elegíveis: *pesquisadores com publicação indexada sobre DATM no PubMed*, m*embros da ORADLIST* e *contato individual.* O link de acesso ao questionário foi enviado por email aos voluntários interessados em participar os quais preencheram os critérios de inclusão. A amostra foi composta por especialistas em radiologia com experiência na interpretação de imagens seccionais (TC, TCFC e/ou RM) da articulação temporomandibular (ATM) que responderam um questionário na língua inglesa, desenvolvido e mantido online (LimeSurvey 1.87+). Num período de três meses, duas notificações foram enviadas e um prazo de 40 dias após a última notificação foi estabelecido para o envio das respostas. O questionário foi dividido em três partes com perguntas fechadas e abertas. A parte I relacionava-se às questões de identificação do participante (gênero, idade, país de atuação, área de atividade, tempo de experiência como radiologista e na interpretação de imagens seccionais da ATM e o tempo de dedicação mensal à atividade de interpretar imagens seccionais da ATM). A parte II continha questões relacionadas à adequação dos critérios propostos para interpretação das imagens seccionais da ATM como parte do RDC/TMD. Os critérios foram apresentados em tabelas de duas colunas e os participantes eram questionados se aquele conjunto de critérios era considerado adequado ou não para a interpretação e diagnóstico dos tecidos ósseos e não-ósseos da ATM de acordo com cada modalidade de imagem. Caso não os considerasse adequado, deveria indicar qual o tipo de sugestão: se inserção de novos items, a modificação ou eliminação de itens existentes. A parte III continha perguntas relacionadas à necessidade de se incluir um protocolo técnico mínimo para a aquisição de TC, TCFC e RM como parte do RDC/TMD. Caso considerasse necessário, deveria indicar qual seria sua sugestão de protocolo para aquisição de cada uma das técnicas de imagem (TC, TCFC e RM). Cinqüenta e sete radiologistas de vários países responderam o questionário. Os resultados indicam que 87 a 98% dos radiologistas consideraram os critérios adequados e que 81,6% dos respondentes consideram necessária a inclusão de um protocolo técnico mínimo para aquisição das imagens por TC, TCFC e RM como parte do RDC/TMD. Dois a treze porcento dos respondentes sugeriram inserção, modificação e eliminação de items nos critérios propostos. Noventa porcento dos respondentes consideram necessária a inclusão de protocolo técnico mínimo para TC/TCFC e 81.7% para a RM. Conclui-se que, de acordo com a opinião da comunidade mundial de especialistas em radiologia, é mínima a necessidade de ajustes nos critérios para interpretação de imagens seccionais da ATM, entretanto, é clara a necessidade da inclusão de um protocolo técnico mínimo para a aquisição das referidas imagens como parte do protocolo de normatização das pesquisas que utilizam o RDC/TMD.

Palavras-Chave: Desordens da articulação temporomandibular, Diagnóstico por Imagem, Interpretação de imagem assitida por computador, Imagem por Ressonância Magnética, Tomografia Computadorizada por Raios X.

ABSTRACT

The aim of this study was to investigate the opinion of specialists in radiology, from different parts of the world, regarding to the proposed criteria for image acquisition and interpretation by Computed Tomography (CT), Cone Beam Computed Tomography (CBCT) and Resonance imaging (MRI) in diagnosing temporomandibular joint disorders (DATM) as part of Diagnostic Criteria for Research of Temporomandibular Disorders (RDC/TMD). Radiology specialists were invited by email to participate as volunteers in the study from three different eligible populations: researchers with publication DATM indexed on PubMed, ORADLIST members and individual contact. The link to access the questionnaire was mailed to volunteers interested in participating who matched the inclusion criteria. The sample was composed of specialists in radiology with experience in the interpretation of sectional images (CT, CBCT and/or MRI) of the temporomandibular joint (TMJ) who answered a questionnaire in English, which was developed and maintained online (LimeSurvey 1.87+). In a three months period, two recalls were sent and a period of 40 days after the last notification was given for responses submission. The questionnaire was divided into three parts with closed and open questions. Part I was related to issues of participant identification (gender, age, country of activity, area of activity, time and experience as a radiologist in the interpretation of sectional images of the TMJ and monthly time dedicated to the activity of interpreting sectional images of ATM). Part II contained questions related to the adequacy of the proposed criteria for the interpretation of sectional images of the ATM as part of the RDC/TMD. The criteria were presented into two columns' tables and the participants were asked whether that set of criteria was considered adequate or not for assessement and diagnosis of TMJ osseous and non-osseous tissues according to each imaging modality. If the respondent not considered criteria appropriate, he/she should indicate what type of suggestion: if insertion of new items, the modification or deletion of existing items. Part III had questions related to the need to include a minimal technical protocol for TMJ CT, CBCT and MRI acquisition as part of the RDC/TMD. If deemed necessary, the respondent should indicate which would be his/her suggestion protocol for acquisition of each imaging technique (CT, CBCT and MRI). Fifty-seven radiologists from different countries completed the questionnaire. The results indicate that 87 to 98% of radiologists considered the criteria adequate and that 81.6% of respondents considered necessary to include a minimal technical protocol for CT, CBCT and MRI acquisition as part of the RDC/TMD. Two to thirteen percent of respondents suggested insertion, modification and deletion of items in the proposed criteria. Ninety percent of respondents considered necessary to include a minimal technical protocol for CT/CBCT and 81.7% for MRI. We conclude that, according to the opinion of the worldwide community of specialists in radiology, the need for adjustments in the criteria for assessment of sectional images of the ATM is minimal, however, the need for the inclusion of a protocol to acquire minimal technical parameters of those images as part of protocol standardization of studies using the RDC/TMD is clear.

Keywords: Temporomandibular joint disorders; Diagnostic Imagin;, Image Interpretation, Computer-Assisted; Magnetic Resonance Imaging; Tomography, X-Ray Computed.

1 CARACTERIZAÇÃO DO PROBLEMA

Um dos maiores desafios para os profissionais que tratam as desordens temporomandibulares (DTM) é o estabelecimento de um diagnóstico apropriado para a obtenção do sucesso terapêutico. Essa tarefa se torna complexa devido à etiologia multifatorial, às manifestações clínicas semelhantes e à sobreposição de múltiplos sinais e sintomas das DTM (American Academy of Orofacial Pain, 1996; Okeson, 2008). Além disso, a multiplicidade e falta de padronização da nomenclatura, taxonomia, critérios de diagnóstico; bem como na execução do exame clínico do paciente, além de pesquisas com resultados variados, compõe a realidade no campo das DTM 35,36.

A literatura relata uma ampla variabilidade na prevalência desta condição nas diversas populações estudadas, refletindo a diversidade de critérios clínicos utilizados 35,36. Alguns estudos avaliam a prevalência de sinais e sintomas (variando de 7-84% na população geral) (Roda et al., 2007), enquanto outros avaliam a prevalência dos diversos subtipos de DTM 35,36. A consciência dos profissionais para diagnosticar e tratar o paciente com DTM geralmente é limitada, podendo levar a tratamentos desnecessários (Kuttila et al., 1997). Além disso, apesar de apenas 3-7% dos pacientes com DTM procurarem por tratamento, uma enorme despesa pode ser gerada não somente para o indivíduo que busca tratamento, mas também para os cofres públicos 35,36.

Critérios clínicos de diagnóstico foram desenvolvidos numa tentativa de uniformizar a classificação das DTM e permitir a reprodutibilidade das pesquisas no referido domínio. Dentre essas iniciativas, destacam-se o guia para a avaliação, diagnóstico e tratamento das DTM da *American Academy of Orofacial Pain* (AAOP), mais voltado para a prática clínica (American Academy of Orofacial Pain, 1996) e o Re*search Diagnostic Criteria for*

Temporomandibular Disorders (RDC/TMD) 1, um sistema de diagnóstico e classificação das principais DTM de origem muscular e articular, elaborado por um grupo de pesquisadores para ser utilizado em pesquisas.

No processo de diagnóstico das desordens da articulação temporomandibular (DATM), exames por imagem têm sido recomendados, porém os critérios de prescrição desses exames têm sido bastante discutidos, sendo que o minucioso exame clínico do paciente é apontado como a base para esses critérios 35,36. Apesar do notável avanço tecnológico dos métodos de exame por imagens, o que inclui a Tomografia Computadorizada (TC), a Tomografia Computadorizada por Feixe Cônico (TCFC) e a Ressonância Magnética (RM) na avaliação das articulações temporomandibulares (ATM), com elevados índices de acurácia 35,36, a real contribuição desses exames no diagnóstico e terapêutica dessas desordens tem sido discutida 28. Um dos questionamentos ocorre em torno do entendimento de que a eficácia de um método de diagnóstico não se resume à adequação técnica do mesmo, mas se trata de uma interação complexa entre a produção da imagem e a pessoa que irá interpretá-la 6.

A TC tem sido descrita como um dos melhores métodos para avaliar a ATM quando a suspeita clínica relaciona-se aos tecidos ósseos 35,36. A TCFC tem sido apontada como método de escolha substituindo a TC, por ser um exame que tem menor custo financeiro e biológico para o paciente, por gerar menor dose de radiação 35,36. A imagem por RM, por sua vez, tem sua principal contribuição quando o foco da investigação são as partes moles, sendo considerada método de referência 35,36.

Apesar do RDC/TMD recomendar exames por imagem como parte do processo de diagnóstico de algumas DATM, apenas recentemente foi realizado um estudo para o estabelecimento de critérios para a interpretação dos exames por imagem convencionais e seccionais da ATM, como parte do RDC/TMD 7. Neste estudo, os autores avaliaram a validade dos critérios propostos por meio da avaliação da concordância interexaminador na interpretação de radiografias panorâmicas, TC e RM da ATM. Três radiologistas diplomados, com 12 a 23

anos de experiência na interpretação de imagens da ATM, avaliaram 1448 articulações de 724 participantes no estudo. Tendo a TC como método de referência, investigaram a validade dos critérios propostos no estudo para a avaliação dos tecidos ósseos da ATM utilizando a radiografia panorâmica e RM e para a avaliação dos tecidos não-ósseos da ATM por meio da RM. Utilizando a estatística kappa, encontraram que, para o diagnóstico radiológico da osteoartrite os critérios possuíam uma confiabilidade interexaminador pobre utilizando a radiografia panorâmica, razoável utilizando a RM e próximo a excelente utilizando a TC. Por sua vez, os critérios tiveram uma confiabilidade excelente para o diagnóstico do deslocamento do disco com e sem redução e boa para o diagnóstico de efusão utilizando a RM. Concluíram que os critérios podem ser confiavelmente utilizados para a avaliação da osteoartrite utilizando a TC e para a avaliação da posição do disco e efusão utilizando a RM.

O conhecimento da adequação desses critérios propostos para a interpretação de imagens, bem como da necessidade do estabelecimento de um protocolo técnico mínimo de aquisição dessas imagens como parte do protocolo de pesquisas, para garantir a eficácia técnica das mesmas, pode ser relevante para aumentar a validade do RDC/TMD. Consequentemente pode-se contribuir para a reprodutibilidade das pesquisas e comparação de resultados, facilitando estudos envolvendo níveis mais elevados de eficácia, em que o impacto sócio-econômico desses exames de alto custo possa ser investigado.

1.1 UMA REFLEXÃO SOBRE EFICÁCIA NO CONTEXTO DOS MÉTODOS DE DIAGNÓSTICO

Em geral, em epidemiologia os termos eficácia e acurácia são definidos no contexto de estudos de intervenções terapêuticas. Eficácia como a “capacidade de demostrar que um tratamento pode funcionar” (Fletcher et al., 2002) ou como a “probabilidade de beneficiar indivíduos de uma determinada população por uma tecnologia médica aplicada em um dado problema clínico, sob condições ideais de uso” 6. Acurácia ou validade, como o grau pelo qual os dados medem o que pretendem medir (Fletcher et al., 2002).

Entretanto, no contexto da avaliação de métodos de diagnóstico, o modelo hierárquico de eficácia, proposto por Fryback e Thornbury (1991), parece ser mais apropriado. Este modelo considera a acurácia como um dos níveis mais baixos de avaliação da eficácia. Esta hierarquia é dividida em seis níveis, que vai desde a eficácia dos princípios técnicos do método (nível 1), passa pela prática clínica (níveis 2 a 4), até a eficácia das informações fornecidas pelo método no resultado do tratamento do paciente (nível 5) e para a sociedade (nível 6). Numa visão mais global, a imagem de diagnóstico é parte de um sistema cujo objetivo primordial é tratar os pacientes efetiva e eficazmente, e não apenas identificar acuradamente uma determinada estrutura anatômica ou lesão. Neste contexto amplo, mesmo aqueles exames que fornecem imagens de alta qualidade de diagnóstico da ATM, como as imagens por RM, podem não contribuir para modificar o diagnóstico clínico e/ou tratamento previsto.

1.2 QUESTÕES QUE NORTEARAM O ESTUDO

O presente estudo visou responder alguns questionamentos identificados pela equipe de pesquisadores após a publicação, por Ahmad et al 35,36, dos critérios de interpretação e diagnóstico dos tecidos ósseos e não-ósseos da ATM:

Os critérios propostos para a interpretação das radiografias panorâmicas e imagens por TC, TCFC e RM no diagnóstico das DATM, como parte do RCD/TMD, são considerados suficientes, efetivos e aceitos pela comunidade mundial de especialistas em radiologia?

Considerando o modelo hierárquico de avaliação da eficácia de um método de diagnóstico e a evolução e diversificação dos equipamentos e protocolos para a aquisição de imagens, como garantir a adequação técnica de imagens seccionais no contexto das pesquisas em DTM, para que níveis mais elevados de eficácia de

diagnóstico dessas técnicas possam ser investigados utilizando o RDC/TMD?

OBJETIVOS

2.1 OBJETIVO GERAL

Investigar a opinião de especialistas em radiologia, de várias partes do mundo, quanto aos critérios propostos para a aquisição e interpretação de imagens por TC, TCFC e RM no diagnóstico das DATM como parte do RDC/TMD.

2.2 OBJETIVOS ESPECÍFICOS

Considerando o diagnóstico por imagem como parte de um conjunto de procedimentos requeridos para o diagnóstico das DTM, nos propusemos a:

- Verificar se na opinião dos radiologistas os critérios propostos como parte do RDC/TMD para interpretação de imagens por TC, TCFC e RM são adequados para identificar as possíveis alterações ósseas da ATM
- Identificar se os critérios propostos como parte do RDC/TMD para interpretação de imagens por RM na opinião de radiologias são adequados para o diagnóstico dos tecidos não-ósseos da ATM
- Averiguar a opinião dos especialistas em radiologia quanto a necessidade da inclusão de um protocolo técnico mínimo para a aquisição de imagens (TC, TCFC e RM) como parte do RDC/TMD
- Identificar os principais requisitos para o desenvolvimento de um protocolo mínimo para a aquisição de imagens por TC, TCFC e RM com a finalidade de diagnóstico das DATM no contexto do RDC/TMD, a partir da opinião de radiologistas atuantes em várias

partes do mundo.

HIPÓTESES

Os critérios para interpretação de imagens por TC, TCFC e RM da ATM como parte do RDC/TMD serão considerados adequados pela comunidade mundial de especialistas em radiologia.

A inclusão de um protocolo técnico mínimo para a aquisição das imagens seccionais da ATM como parte do RDC/TMD será considerada necessária.

MÉTODO

4.1 TIPO DE ESTUDO E QUESTÕES ÉTICAS

Este protocolo de pesquisa do tipo descritivo foi conduzido após apreciação e aprovação pelo Comitê de Ética em Pesquisa da UFG (protocolo 010/10, **ANEXO 1**), bem como mediante a aceitação do Termo de Consentimento Livre e Esclarecido - TCLE (**APÊNDICE 1** – versão original em inglês), vinculado ao instrumento de coleta de dados para a pesquisa, descrito a seguir.

POPULAÇÃO ELEGÍVEL

Três diferentes populações elegíveis, as quais potencialmente teriam a chance de incluir especialistas em radiologia, representantes de cada um dos continentes (americano, europeu, africano, asiático e oceânico), foram convidados a participar do estudo. A Figura 1 apresenta as estratégias adotadas para o acesso aos potenciais participantes.

4.2.1. Pesquisadores com publicação sobre DATM indexada na base de dados do PubMed

Para acessar os potenciais participantes por esta estratégia, foi realizada busca sistemática na base de dados do PubMed, utilizando termos indexados (Figura 1).

O ano de 1990 foi considerado como limite inicial para busca por ter sido a década em que houve a difusão da internet e que se completaram dez anos da introdução da técnica de imagem considerada o padrão-ouro para avaliação da ATM na prática clínica: a RM. Ou seja, a partir de quando mais

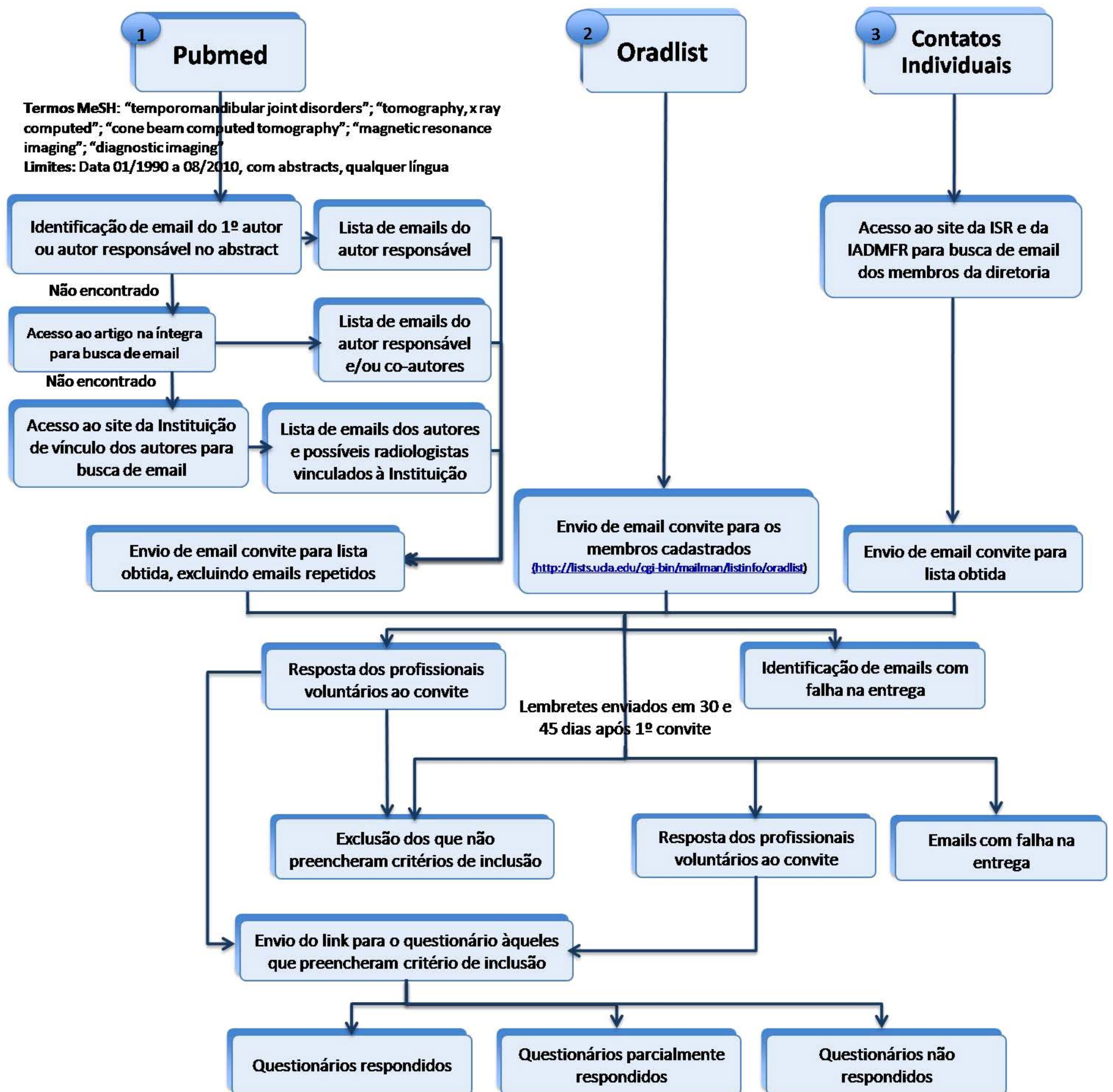

FIGURA 1. Estratégias adotadas para acesso aos potenciais participantes. (MeSH: termos indexados na base de dados do PubMed. ISR: International Society of Radiology. IADMFR: International Association of Dentomaxillofacial Radiology.)

provavelmente se poderiam obter endereços eletrônicos de radiologistas experientes na interpretação de imagens seccionais da ATM.

Os emails dos primeiros autores ou dos autores responsáveis pela publicação foram obtidos no abstract e quando esta informação não estava disponível, o artigo na íntegra ou o site da instituição à qual os autores eram vinculados foi acessado.

Considerando-se que esta estratégia de recuperação de emails dos autores poderia incluir endereços de médicos radiologistas, ortodontistas, cirurgiões bucomaxilofaciais, protesistas e outros pesquisadores da área médica, para o cálculo da população elegível, o departamento da Instituição à qual os autores da publicação eram vinculados foi identificado. Caso o departamento fosse relacionado à área de diagnóstico (Departamento de Ciências de Diagnóstico Odontológico, Diagnóstico por Imagem, Ciências de Diagnóstico, Ciências Cirúrgicas e de Diagnóstico, Neuroimagem, Neurologia, Radiologia Oral e Maxilofacial, Ciências da Saúde Oral, Medicina Oral e Radiologia), o email obtido era considerado como sendo de potencial radiologista.

4.2.2. Membros da ORADLIST

A ORADLIST (http://lists.ucla.edu/cgi-bin/mailman/listinfo/oradlist) é uma lista de discussão virtual mundial composta por pessoas com particular interesse em Radiologia Oral e Maxilofacial. Esta lista inclui radiologistas, ortodontistas, estudantes e membros da indústria, além de endereços duplicados.

Segundo informações obtidas com o administrador da lista, em torno de 28% dos membros listados poderiam ser especialistas em radiologia.

4.2.3. Contatos individuais

Um email foi enviado para os presidentes das duas principais associações internacionais de Radiologia – A International Society of Radiology (ISR) e a International Association of Dentomaxillofacial Radiology (IADMFR) solicitando a colaboração no intuito de encaminhar aos seus associados o convite para participação na pesquisa.

Da mesma forma, alguns radiologistas conhecidos pelo grupo de pesquisa, os quais não responderam à solicitação de preencher o questionário por uma das três formas acima mencionadas, foram contatados individualmente por email ou por telefone.

4.2.4. Amostra

A amostra, do tipo não probabilística por conveniência, foi composta apenas por especialistas em radiologia com experiência na interpretação de imagens seccionais da ATM que, além de responderem ao email convite solicitando o link para participar, concordaram em responder o questionário na língua inglesa (**critérios de inclusão**).

INSTRUMENTO DE PESQUISA

Um questionário autoaplicável foi utilizado como instrumento de coleta de dados, com questões fechadas e abertas. O referido questionário, alicerçado nos objetivos do estudo, foi elaborado na língua inglesa, especificamente para esta pesquisa (**APÊNDICE 2**) através da ferramenta LimeSurvey 1.87+ (LimeSurvey™, Free Software Foundation, Inc., Fa. Carsten Schmitz, Germany). O instrumento foi submetido às etapas de revisão e pré-teste antes de ser enviado para os especialistas que compuseram a amostra.

4.3.1 Revisão

Com a finalidade de avaliar a estrutura do questionário, cinco profissionais analisaram a primeira versão do mesmo, os quais sugeriram a alteração de algumas questões para maior clareza e entendimento. Estes profissionais eram pesquisadores e professores universitários em Odontologia, com experiência em pesquisa quanti e/ou qualitativa e/ou na área temática desse estudo (DTM).

4.3.2. Pré-Teste

Após as adequações realizadas com base nas sugestões dos revisores, o questionário foi submetido ao pré-teste com o propósito de analisar o grau de complexidade ou clareza das questões contidas no instrumento de coleta de dados, tempo de leitura e resposta do TCLE e do questionário. Um grupo de cinco radiologistas, sendo três radiologistas da Universidade de Malmö e dois atuantes na prática privada no Brasil, foi convidado para essa etapa. Após o pré-teste, novas adequações foram implementadas para maior precisão do instrumento.

4.3.3.Teste Piloto

O teste piloto não foi realizado pela impossibilidade de se conduzir uma escolha aleatória dos voluntários para participarem de uma simulação da aplicação do instrumento. O principal responsável por tal dificuldade foi a forma de acesso à população elegível (email) e o tipo da amostra de conveniência, ou seja, indivíduos que receberam email convite, solicitaram link para o questionário e aceitaram respondê-lo.

4.3.4. Versão Online

O questionário foi elaborado e disponibilizado em uma versão para internet. Além das perguntas pertinentes ao objetivo da investigação, o instrumento incluiu uma apresentação com informações sobre as finalidades da pesquisa, equipe responsável e instruções para o preenchimento e envio do mesmo. Apenas os interessados em participar que responderam ao email-convite receberam um novo email contento o link direcionando para o instrumento de pesquisa. A aceitação do TCLE foi pré-requisito para o início do

preenchimento do questionário.

A ferramenta utilizada para o desenvolvimento do questionário garantiu a privacidade e sigilo para os participantes quanto às informações prestadas, mantendo seus dados confidenciais. Ela possibilitou ainda, que cada participante pudesse criar uma senha de acesso e realizasse o preenchimento em várias etapas, de acordo com a conveniência do respondente.

O questionário foi dividido em três partes:

Parte I – Identificação: com questões fechadas sobre gênero, área de atividade e país de atuação profissional; questões abertas sobre o tempo de experiência em radiologia e de dedicação à interpretação de imagens seccionais da ATM.

Parte II – Adequação dos critérios de intepretação de imagens: Nesta parte foram utilizadas as tabelas apresentadas na publicação original de Ahmad, Hollender, Anderson et al (2009) (Figuras 1 a 4) com algumas modificações. As tabelas originais foram elaboradas focando-se na distribuição dos critérios de acordo com o tipo de tecido analisado e foram apresentadas no formato de duas colunas: uma coluna contendo as opções de escore e a outra os critérios de escore que caracterizavam cada opção de escore apresentado.

As tabelas da ferramenta de pesquisa foram adaptadas a partir das tabelas originais para permitir aos respondentes focar seus pensamentos no tipo de tecido e nas técnicas de imagem em que aqueles tecidos podem ser avaliados. Nenhum tipo de alteração foi feita no conteúdo dos critérios originais. As adaptações feitas foram somente nos títulos e na aparência das tabelas. Assim, o questionário online foi composto por cinco tabelas:

Tabela 1 – Critérios para interpretação dos tecidos ósseos da ATM utilizando TC e TCFC. Corresponde à primeira tabela da publicação original de Ahmad, Hollender, Anderson et al. (2009) com adaptações: o critério para radiografia panorâmica foi removido, a TCFC foi acrescentada no título da tabela sem alteração no conteúdo da mesma e os critérios para RM foram transferidos para uma nova tabela

Tabela 2 - Critérios para interpretação dos tecidos ósseos da ATM utilizando RM. Esta tabela não existia na publicação original e foi construída com os critérios para RM da primeira tabela da publica original

Tabela 3 - Critérios para o diagnóstico dos tecidos ósseos da ATM utilizando TC, TCFC e RM. Esta tabela corresponde à segunda tabela da publicação original (Figura 2). Adaptações: o critério para radiografia panorâmica foi removido, a TCFC foi acrescentada no título da tabela sem alteração no conteúdo da mesma

Tabela 4 - Critérios para interpretação dos tecidos não-ósseos da ATM utilizando RM. Corresponde à terceira tabela da publicação original (Figura 3)

Tabela 5 - Critérios para o diagnóstico dos tecidos não-ósseos da ATM utilizando RM. Corresponde à quarta tabela da publicação original (Figura 4)

Para cada tabela, os participantes eram questionados se consideravam os critérios propostos adequados. Caso o respondente considerasse algum critério como não adequado, ele tinha quatro opções para sugestões: inserção de novo(s) item(s), modificação ou eliminação de item(s) proposto(s) ou espaço para outras sugestões que não as anteriores.

Parte III - Necessidade de acrescentar critérios técnicos para a aquisição de imagens utilizando o RDC/TMD: os respondentes eram questionados sobre a necessidade de se incluir ou não um protocolo técnico mínimo para a aquisição de imagens seccionais da ATM como parte do RDC/TMD:

"Considerando que a acurária de qualquer exame por imagem é uma interação complexa entre a imagem e a pessoa que a interpreta e os critérios propostos no RDC/TMD são relacionados apenas ao examinador, qual é a sua opinião a respeito de incluir sugestões de um protocolo técnico mínimo para a aquisição das imagens da ATM (TC, TCFC e RM) como parte do RDC/TMD?" Quando o participante respondia positivamente, ele tinha a opção de considerar sugestões de protocolos técnicos mínimos para a TC/TCFC e RM separadamente:

"Você sugeriria um protocol técnico mínimo para a aquisição das imagens por TC e TCFC para avaliar a ATM?"

Posição do paciente: (Escolha uma das seguintes opções)

Boca fechada em oclusão (posição de máxima intercuspidação)

Boca aberta no máximo que o paciente possa tolerar, com o uso de um aparelho de abertura bucal

Ambas posições acima

Outra

Nenhuma resposta

Se você considerer posições diferentes para cada um dos métodos (TC, TCFC), coloque sua resposta no campo "outras sugestões".

Vistas seccionais (TC) (escolha uma das seguintes respostas)

Axial, com posterior reformatação de imagens nos planos sagital e coronal

Axial, sagital e coronal diretos

Sagital direto apenas

Outros

Nenhuma resposta

Outras sugestões

"Você sugeriria um protocolo técnico mínimo diferente do abaixo para a aquisição da RM para avaliar a ATM?"

Posição de boca fechada, Spin-echo, High field

Localizador axial

Sagital obliquo, corrigidos axialmente de acordo com longo eixo do côndilo, Densidade de Próton (PD) ou T1, bilateral

Coronal obliquo, corrigido axialmente de acordo com longo eixo do côndilo, Densidade de Próton (PD) ou T1, bilateral

Posição de boca aberta, Spin-echo, High field

Localizador axial

Sagital obliquo, corrigidos axialmente de acordo com longo eixo do côndilo, Densidade de Próton (PD) ou T1, bilateral

Coronal obliquo, corrigido axialmente de acordo com longo eixo do côndilo, T2, bilateral

O conjunto de opções foi apresentado com base na literatura. A possibilidade de inserir outras sugestões para cada técnica também foi fornecida através dos campos abertos para as respostas.

A Radiografia Panorâmica não foi incluída na ferramenta de pesquisa, pois os resultados de Ahmad, Hollender, Anderson et al (2009) mostraram sua pobre confiabilidade e baixa sensibilidade, comparada com a TC para a detecção de alterações ósseas da ATM. Além disso, a avaliação das imagens por TCFC foi adicionada no questionário online, por ser uma modalidade de imagem tomográfica com menor dosagem de radiação e seu uso tem se tornado mais amplo na prática 22. Os critérios originais não incluíam TCFC 7.

A resposta em cada uma das questões das Partes I e II era obrigatória para passar para a próxima questão.

Na última questão do questionário o participante era questionado se havia tido alguma dificuldade em respondê-lo.

ANÁLISE DOS DADOS

As respostas foram depositadas automaticamente em um banco de dados próprio da ferramenta, sendo as questões não respondidas foram excluídas da análise dos dados. Um prazo de 40 dias foi fornecido após o envio do último email lembrete, para que os participantes pudessem enviar suas respostas e os pesquisadores pudessem proceder com a análise dos dados.

Os dados coletados foram exportados da ferramenta para serem analisados e tabulados utilizando-se o programa SPSS Statistics 17.0 (*SPSS Inc*, Chicago, IL, USA) e as respostas descritas na forma de freqüência absoluta e relativa. Uma categorização das respostas abertas foi realizada de forma consensual entre pelo menos três pesquisadores.

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5 RESULTADOS / PUBLICAÇÕES

Os resultados serão apresentados no formato das duas publicações às quais deram origem. Os dois artigos científicos serão submetidos à Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology, cujas normas de publicação encontram-se no ANEXO 3.

Artigo 1 – Diagnostic imaging in the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) – Part 1: evaluation by experient radiologists worldwide.

Artigo 2 – Diagnostic imaging in the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) – Part 2: a technical protocol for acquiring TMJ images should be included?

Diagnostic imaging in the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) – Part 1: evaluation by experient radiologists worldwide.

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Diagnostic imaging in the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) – Part 1: evaluation by experient radiologists worldwide.

ABSTRACT

Objective: To investigate the opinion of radiologists worldwide regarding the adequacy of the criteria proposed as part of Research Diagnostic Criteria for Temporomadibular Disorders (RDC/TMD) for interpreting and diagnosing temporomandibular joint (TMJ) disorders by computed tomography, cone-beam computed tomography and magnetic resonance images. **Study design:** An email invitation was sent to TMJ researchers, Oradlist members and individual contacts. Inclusion criteria required radiologists with experience interpreting TMJ sectional images. The link to the online questionnaire was sent to those who match the inclusion criteria and was interested to contribute to the study. Questions approached their opinion about adequacy of previously published criteria. **Results:** Fifty seven respondents completed the questionnaire and 87-98% of them considered criteria adequate for TMJ sectional imaging assessment and diagnosis. Insertion, modification and/or elimination of criterion were suggested by 2-13% of respondents. **Conclusion:** Criteria for TMJ sectional images using RDC/TMD are considered adequate for research purposes according to worldwide radiologists assessment. A few adjustments could make it more effective.

KEYWORDS: temporomandibular joint disorders; diagnostic imaging; image interpretation, computer-assisted; magnetic resonance imaging; tomography, x-ray computed; cone-beam computed tomography.

INTRODUCTION

The need and importance of adopting standardized criteria for classification and reproducibility of research in the field of temporomandibular disorders (TMD) has long been recognized. Among the diagnostic criteria developed in that domain, stands a diagnosis and classification system of main TMD conditions (myogenic and joint): the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).1 The RDC/TMD has been reformulated and revised in many aspects by several researchers.35,36

In spite of the RDC/TMD has recommended imaging tests as part of diagnostic process in some temporomandibular joint disorders (TMJD), only recently a study has been undertaken to draw up criteria for the assessment of the TMJ tests using conventional and sectional images, as part of the RDC/TMD.7 These authors assessed the validity of the criteria proposed by the evaluation of interexaminer agreement in the assessment of panoramic radiographs, CT and MRI of the TMJ. Three Board Diplomate radiologists, with 12 to 23 years of experience in interpreting TMJ images, evaluated 1448 joints from 724 study participants. Taking CT as the reference method, the authors studied the validity of the criteria in the TMJ osseous tissues evaluation using panoramic radiography and MRI, and the validity of the criteria in the TMJ non-osseous tissues evaluation by using MRI. The kappa statistic was applied and they found that for the radiological diagnosis of osteoarthritis, the criteria had poor interexaminer reliability for panoramic radiography, fair for MRI and close to the threshold of excellent for CT. Using MRI, the criteria reliability was excellent for diagnosing disc displacements with or without reduction and good for effusion. They

concluded that the criteria could reliably be used for assessment of osteoarthritis using CT and for disc position and effusion using MRI.

Knowledge of the adequacy of these criteria for image assessment could be important for improving the effectiveness of the RDC/TMD. Consequently, it would contribute to the reproducibility of research and the possibility of comparing results, thereby facilitating studies involving greater levels of effectiveness, in which the socio-economic impact of these very costly tests could be investigated.

This study was split in two parts, which were performed to respond some issues that arose after the study by Ahmad et al.:7 Are the criteria proposed for the assessment of images using Computed Tomography (CT), Cone Beam Computed Tomography (CBCT) and Magnetic Resonance (MR) images, considered adequate in the diagnosis of TMJD, as part of the RCD/TMD according to the evaluation of the global community of radiology specialists? Taking the complexity of the accuracy of a diagnostic method and the development and diversification of equipment and protocols, how can their technical adequacy be guaranteed in the context of RCD/TMD? The first question is related to the goals of this current publication and the second question is going to be approached in the second part of this investigation.

The aim of this study was to investigate the opinion of radiology specialists from different parts of the world regarding to the adequacy of the criteria proposed as part of the RDC/TMD for interpreting and diagnosing TMJD by using CT, CBCT and MR images.

METHODS

Study design and ethical questions

This descriptive study was undertaken after approval by the Research Ethics Committee of Federal University of Goias (UFG), Brazil.

Eligible population

Radiology specialists from all continents (American, European, African, Asian and Oceanian), were invited to take part of this study. Three different eligible populations, which potentially would have a chance of having radiologists, were accessed:

TMJD Researchers with studies indexed in PubMed database – To access potential participants, a systematic search in PubMed database was held, using MeSH terms relating to the research theme ("temporomandibular joint disorders"; "tomography, x ray computed"; "cone beam computed tomography"; "magnetic resonance imaging"; "diagnostic imaging"). Search was limited to Entrez date from 01/1990 to 08/2010, with abstracts and published in any language. The year of 1990 was considered as initial date because it was the decade of the diffusion of internet and when it was completed 10 years from the clinical introduction of imaging gold standard for TMJD: MRI. That is, from when most probably the email addresses of experienced radiologists in the assessment of sectional images of the TMJ could be retrieved. Corresponding authors' email addresses were obtained from the abstract and when it was not available, the article in full or the website of the Institution to which the authors were affiliated was accessed to obtain this information.

Whereas this strategy of retrieving the corresponding authors

emails could include email addresses from radiologists, orthodontists, maxillofacial surgeons, prosthetists and other health researchers, in order to determinate the eligible population we considered the Institution/department of the corresponding author. If it was related to the diagnostic field (Departments of: Dental Diagnostic Science, Diagnostic Imaging, Diagnostic Sciences, Diagnostic and Surgical Sciences, Neuroimaging, Neurology, Oral and Maxillofacial Radiology, Oral Health Sciences, Oral Medicine and Radiology), the email retrieved was considered as being from a potential radiologist.

ORADLIST members – It is a worldwide conference mailing list (http://lists.ucla.edu/cgi-bin/mailman/listinfo/oradlist) in which members have a particular interest in Oral and Maxillofacial Radiology. It includes radiologists, orthodontists, industry members and duplicate addresses. According to information obtained from the administrator of the list, about 28% of 738 members listed could be radiologists.

Individual Contacts - An email was sent to the presidents of two leading international associations of Radiology - The International Society of Radiology (ISR) and The International Association of Dentomaxillofacial Radiology (IADMFR) - requesting cooperation in order to forward the email invitation to their members as collaboration with this research. At the same way, some radiologists well known by the research group, who did not answer to the request to complete the questionnaire by one of three paths already mentioned, were contacted individually by email or by phone.

Sample

The sample included only those radiologists experienced in the assessment of sectional images of the TMJ who replied the invitation email, match the inclusion criteria and agreed to answer the questionnaire in English.

Research tool

A self-administered questionnaire, which was drawn up in English and made available on the internet, was used to data collection through the LimeSurvey 1.87+ tool (*LimeSurvey™, Free Software Foundation, Inc., Fa. Carsten Schmitz, Germany*). The questionnaire underwent the stages of review and pre-test before being submitted for assessment by the specialists making up the sample. Willing volunteers who responded to the invitation email received the link to the questionnaire. In addition to questions, the tool also included an introduction page with information on the aims of the research, the team responsible and instructions on how to complete and send the questionnaire back. Acceptance of the informed consent linked to the data collection tool was a prerequisite for answering to it. The questionnaire was divided into three parts as follows:

Part I – Identification: it comprised closed questions about gender, main professional field, working country and opened questions about time working as radiologist (interpreting images) and time of experience in interpretation of TMJ sectional images. Just a few questions of this part were not mandatory.

Part II – Adequacy of criteria for analysing images: In this part we use the tables I to IV presented in the original publication by Ahmad et al.7 (Figures 1 to 4) with some adaptations. These original tables were built

focusing on the distribution of the criteria according to the type of tissue analyzed. They were presented in two columns table format: one column containing the scoring options and another with the scoring criteria that characterized each scoring option presented.

Research tool tables were adapted to allow the respondent focus thoughts in the type of tissue and on techniques that those tissues could be investigated. No changes were made in the content of the original criteria. The adaptations were only either in the heading or displaying of the tables. Thus, the online questionnaire was composed by five tables:

Table 1 - Criteria for assessment of TMJ osseous tissues using CT and CBCT. It corresponds to Ahmad´s[13] first table (Figure 1), with adaptations: Panoramic radiograph criteria was removed, CBCT was added in the heading of the table without changes in the content and MRI criteria was transferred to a new table

Table 2 - Criteria for assessment of TMJ osseous tissues using MRI. This table did not exist in the original publication and was built with MRI criteria from Ahmad´s[13] first original table

Table 3 - Criteria for diagnosis of TMJ osseous tissues using CT, CBCT and MRI. This table corresponds to Ahmad´s second table (Figure 2). Adaptations: Panoramic radiograph criteria was removed, CBCT was added in the heading of the table without changing the content

Table 4 - Criteria for assessment of TMJ non-osseous tissues using MRI. Corresponds to Ahmad´s[13] third table (Figure 3)

Table 5 - Criteria for diagnosis of TMJ non-osseous tissues using MRI. Corresponds to Ahmad´s[13] fourth table (Figure 4)

Participants were asked whether they considered the proposed criteria adequate for each table. When any criteria were considered not adequate, the respondent had four options for suggestions: (a) insertion of new item(s) into the scoring options presented or even a new scoring option; (b) modification of scoring option or scoring criteria under the scoring options and/or (c) deletion of item(s) or scoring criteria under the presented scoring options or a space was given for other suggestions other than the above mentioned.

Part III - The need to add technical criteria for acquiring images using RDC/TMD, which will be further discussed in another publication as the second part of this study.

The completion of each question from Parts II and III was mandatory to go to the next.

In the last question of the questionnaire, the respondent was asked if he/she had experienced any difficulties when completing it.

During a three-month period, two notifications were sent to the participants claiming the response to the questionnaire: 30 and 45 days after the first invitation and availability of the online tool. A 40 days period was considered as deadline for submitting their responses after the last notification.

Data analysis

Responses were automatically set down in the tool database, and then exported to the SPSS Statistics 17.0 Program (SPSS Inc., Chicago, IL, USA). The unanswered questions were excluded from data analysis.

Responses were described in absolute and relative frequency. Categorization of the open responses was undertaken after at least three authors have reached consensus.

RESULTS

Subjects

A flowchart of strategies adopted for accessing eligible population and the number of respondents is presented in Figure 5. A total of 93 individuals answered the invitation email from which 23 were other specialists or refused to participate. From the 70 volunteering radiologists interested in participating, who requested the link to the questionnaire, 57 have answered it making up the sample. Forty-nine percent of the sample (n=29) was obtained after the recalls.

The response rate could be calculated under two points of view: if the eligible population (potential radiologists n= 346) is considered, the overall response rate was 16.5%, but if the volunteers who requested the questionnaire link are considered (n= 70), the response rate was 81,4%.

TMJD Researchers with studies indexed in PubMed database – According to the criteria of corresponding author's institution/department, this search yielded 124 publications with email contact from potential radiologists. Thirty-nine professionals responded to the request by this strategy, but 21 were other specialists who would like to contribute with the research, but did not meet the inclusion criteria. Two radiologists requested their exclusion from the sample due to retirement. This group of eligible population counted with a total of 16 radiologists who requested the link to answer the questionnaire.

ORADLIST members – Considering the total number of subscribers (n=738), it was estimated by the administrator of the list that 207 members are radiologists and supposed to have received our invitation. Fifty-

two radiologists answered back requesting the link to answer the questionnaire.

Individual Contact – Both presidents of the ISR and IADMFR replied to our request saying that they could not assist the research because they did not have an email list of the members. The President of IADMFR requested the link to forward it to a personal contact with experience in the interpretation of TMJ sectional images. Thirteen emails were sent to radiologists known by the authors of this study. Strategy of individual contacts yielded two answered questionnaire.

The relative frequency of the subjects' demographic characteristics is presented in Table I and Figure 6.

Adequacy of TMJ imaging assessment and diagnosis criteria

Respondents' opinion regarding to the adequacy of RDC/TMD image assessment and diagnosis criteria is presented on Figure 7 and Tables II, III and IV. Considering that when the respondent judged a criterion as not adequate, he/she could have suggested insertion, modification or elimination of any scoring criteria or scoring option proposed by Ahmad et al.7, therefore, each of these respondents provided more than one suggestion to the mentioned criteria (Figure 7 and Table II). The number of respondents who had filled out each question from Part II of the questionnaire varied from 53 to 50. Four respondents filled out the questionnaire incompletely, only until Part I.

All suggestions made by those who considered the criteria not adequate were categorized by a consensus of the authors and presented in

Tables III and IV.

Several comments were also made by the respondents in each section from which we highlight:

The “Loose Joint Body” as a scoring criterion in the assessment of osseous tissues might not be seen as a high signal of intensity using MRI and in the assessment of non-osseous tissues might be difficult to be noticed if this is presented as a single loose body.

The disc may not be centered between the condyle and eminence in either the medial or the lateral parts, neither in a direction perpendicular to anterior fossa, in the assessment of the scoring criterion disc displacement under the scoring option “disc position: closed-mouth”.

The scoring options related to disc position (closed and open mouth) as they were presented has a normally shaped disc as a prerequisite. It should be considered that the disc may have an abnormal shape or a slightly abnormal signal that however is well-positioned.

The list of scoring options and criteria to set the diagnosis of osteoarthritis from imaging alone is not appropriate. The diagnosis should be done according to a combination of clinical information, laboratory investigations and imaging but cannot be based on imaging alone.

A few respondents (n=9/49) have experienced some difficulties to

answer the questionnaire. Three of them pointed out the fact of not having experience with MRI and did not have the option of no answering for the adequacy of the MRI criteria question. The other comments were varied and related to technical difficulties, issues to follow the questionnaire flow of information and lack of clarity of some questions.

DISCUSSION

In general, the results of this study showed that the criteria were considered adequate for assessment and diagnosis of TMJ osseous and non-osseous tissues according to evaluation of radiologists all over the world. Only 2-13% of respondents suggested changes in the established criteria by Ahmad et al.[13] The RDC/TMD is undergoing a process of review and validation of changes and our results may collaborate to this issue, providing a global sampling of radiologists' opinion about adequacy of RDC/TMD criteria[13] established to TMJ imaging assessment and diagnosis.

Research tool and Sampling

The online modality of survey presents several advantages, which include low cost, ease delivery not being limited by geographic boundaries and data collection is instantaneous and effortless, among others.14 Literature shows this global trend with online surveys in the field of radiology.35,36

The online questionnaire format, with Tables adapted from Ahmad et al.[7] allowed the respondent analyze the criteria with focus not only in the TMJ tissues but also on each image method that can be used to evaluate them. Although panoramic radiograph has been recommended as a screening tool for TMJ pathology,35,36 Ahmad et al.[7] had shown poor reliability and low sensitivity, compared with CT for detecting TMJ-related osseous changes. Moreover, the criteria proposed by this authors[7] did not include CBCT image assessment, which is a low x-ray dosage CT modality and its use has become wider.[22] Thus, panoramic radiograph was not included in the questionnaire and CBCT was added. Condylar position was

also not included as a scoring option for the assessment of TMJ osseous tissue, as in the original proposed criteria, because there is a lack of evidence in the literature to consider this information for prediction of TMJD.35,36 One respondent considered the need to include this criterion (Table III).

The response rate based on the eligible population (16.5%) can be considered low compared to other studies using the same methodology, which ranged from 17 to 67%.35,36 However, as it was calculated upon estimates it can not reveal actual data. An under or overestimation of the number of potential radiologists who have received our invitation may have occurred. The main difficulties to estimate response rate as closest as possible of the real one was related to the information about how many Oradlist members and researchers with studies indexed in the PubMed database were radiologists. All efforts were made to obtain the highest number of answers, which was expressed in the methodology by the two formal recalls, which raised the sample in almost 50%. The several individual e-mails sent to those who requested the questionnaire link and did not responded for some reason was also an important strategy, which helped to obtain a response rate of 81% if the volunteers who requested the link are considered.

Taking into account self-selection bias or volunteer bias as a distortion in the results, caused when the sample is self-chosen and certain characteristics come to be over-represented because they correlate with the willingness of participants, the results of this study should be considered reliable since the demographic characteristics of the respondents, as

presented, allow us to trust their suggestions.

Two reasons are among those that could explain the higher number of dentomaxillofacial radiologists (n=53) who make up the sample, compared to general radiologists (n=7): the majority of respondents was derived from the Oradlist, which is a list for people with interest in oral and maxillofacial radiology and because most of respondents live in countries in which oral and maxillofacial radiology is recognized as a formal specialty. Ruprecht26 conducted an online research about the recognition of the oral and maxillofacial radiology as a specialty in countries (n=193) around the world. The author found that at least 38 countries from 110 countries argued do that in some form. From the countries which did not recognize the oral and maxillofacial radiology, four (Germany, Iceland, Israel and Japan) were under an application for this specialty recognition and 40 countries did not. Although oral and maxillofacial radiology has been recognized in many countries,26 it is believed that there is a small number of professionals with experience in the interpretation of sectional images of the TMJ, even in those countries, since the knowledge for this expertise has becoming more spread in the last two decades. Despite the medical/general radiology have a large number of practitioners worldwide, those professionals may not be familiar with oral and maxillofacial field, and there was a lesser chance of having professional with experience in interpretation of TMJ sectional images.

If we consider those who answered the online questionnaire completely, a few and diversified comments concerning the possible difficulties encountered in filling out the tool were made (n=9/49,18%). In the context of the entire sample (n=57), the eight incomplete questionnaires

could raise this number, since the respondents could have stopped filling out the tool due to some difficulty.

Adequacy of TMJ imaging assessment and diagnosis criteria

The suggestions given by experienced radiologists on the subject may determine a greater evidence of adequacy of the proposed criteria,7 besides to allow a greater diffusion of them in the worldwide community of radiologists.

Regarding some comments made by respondents, which were considered as suggestion to modify items, some should be highlighted and discussed.

"*I don't agree with this list at all as I don't think it is appropriate to set the diagnosis of osteoarthritis from imaging alone. (…) The diagnosis is according to my opinion a combination of clinical information, laboratory investigations and imaging but cannot be based on imaging alone.*" - We agree with the statement, but it must be remembered that the establishment of criteria for diagnosis is not a simple process, mainly due to individual variability. It becomes even more complex and necessary in the context of TMD, because it is a group of disorders with different etiologies, including some not yet well-understood, studied with various approaches and multiplicity of terminology. The RDC/TMD was one of the steps to allow comparison of study results but its first version1 did not include criteria for additional tests such as images, which also has been carried out and interpreted without minimum criteria. Moreover, its contribution to TMD diagnosis and treatment has been controversial.35,36 We understand the

RDC/TMD1 as a dynamic tool that will undergo periodic reviews while the knowledge grows in the context of these disorders.

RDC/TMD is currently the most used criteria for TMD research standardization.28 Establishing criteria for image assessment aims to make it more complete, improve its accuracy and this was an important step given by Ahmad et al.7 Criteria are necessary to help the development of studies with higher level of diagnostic efficacy (e.g. therapeutic and social efficacy) of sectional images.[35,36]

Five respondents have suggested the need for insertion of joint space dimensions for the assessment of TMJ osseous tissues. According to Ahmad et al7 this criterion was not included because joint space variation may not be a reliable indicator of osteoarthritis.

A few respondents (n= 5) questioned the normal or abnormal position of the disc as it was originally proposed by Ahmad et al (e.g. 11:30 position for normal position).7 Some studies have tried to quantify the disc position35,36 and the majority has been using only the posterior band limit as reference. Ahmad et al.7 adopted the classification by Orsini et al.,35,36 for identifying the location of the posterior band and the intermediate zone of the disc, both in closed and open mouth. Arayasantiparb & Tsuchimochi29 suggested that both the anterior and the posterior bands, in the closed- and open-mouth positions, may be better descriptive of the disc position. Another comment regarding to disc position was that the authors7 considered the disc normally shaped as a prerequisite for all scoring criteria that characterized disc position (normal, indeterminate, displaced and not visible disc). "[*The problem with scoring option regarding disk position is that your*

definitions prerequisites a normally shaped disc. Although a rare bird, it is possible to have a disk with an abnormal shape fx 'bandshaped' or with slighlty abnormal signal that however is positioned in the 'correct' position."] - This is an important consideration, which was also discussed by Kurita et al.35,36: the difficulty in defining the posterior limit of disc posterior band in cases that it was displaced, due to its morphological change. Arayasantiparb & Tsuchimochi29 also found more severe structural changes in the posterior attachment of the disc and the retrodiscal tissue in joints with disc displacement without reduction than in joints with reduction.

Three respondents have suggested to include criteria for posterior, rotational and/or sideways disc displacements which were not included in the assessment of non-osseous TMJ tissue criteria by MRI.7 Literature has shown classification and prevalence of different disc positions through MR images,35,36 but according to Ahmad et al7 increasing the diagnostic options often results in reduced reliability. Even they had considered and evaluated all possible disc positions, the results were classified into only 5 types (normal, disc displacement with reduction, without reduction, indeterminate and disc not visible).

The scoring options related to the TMJ osseous tissues diagnosis, which have used the term osteoarthritis, were the most criticized by those who did not considered the proposed criteria adequate. There is a discussion in the literature regarding to the term to be adopted for designation of TMJ osteoarthritic changes through images since the patient´s symptoms may not be known by radiologist.35,36 This became apparent in our results, where respondents (n= 6) considered that the term "Osteoarthritis" should be

modified by “Degenerative joint changes” or similar terminology when establishing the diagnosis of TMJ osseous tissues by using CT, CBCT and/or MR images. Ahmad et al.7 have also discussed the issue of terminology in their study, whereas the term osteoarthritis was used because is more prevalent in the literature, although they agree that the term degenerative joint disease might be the best term to be used for assessment of image when there is no clinical information available.

Some factors may have contributed to a low response rate and several of the following considerations may also be considered as inherent limitations of this study:

The inclusion criteria - radiologists with experience in assessment of TMJ sectional imaging, who should answer to the questionnaire in English - may have lowered the volunteers. There are many radiologists around the world, but not all of them have experience interpreting sectional images of TMJ. Moreover, there was a need to have certain mastery in the English language to answer the questionnaire. This may also have discouraged many potential participants from countries where English is not an official language.

The questionnaire size may have been an important limitation. It comprised 9 pages and 29 questions. Majority of questions required attention and thinking by respondents.

Many emails sent to some researchers from PubMed may have fallen into the spam box or maybe the email's recipient did not open it for security reasons. This might also explain why most respondents are Oradlisters and not researchers from PubMed.

Some volunteers may not want to open the questionnaire link for security reasons because almost all web browsers led to a warning message when it was accessed. This occurred because *LimeSurvey™* tool is licence free (*Free Software Foundation, Inc., Fa. Carsten Schmitz, Germany*).

Another response bias should be noted regarding to researchers with studies indexed in the PubMed database. Since most researchers are associated to universities, one may consider that most of them may not have time to answer emails or the questionnaire itself due to their activities in the academy. As stated by Vorbeck et al.,15 web is still time-consuming.

Even though the questionnaire has undergone previous stages of review and pretest, a response bias was not noticed before. When the participant was asked about adequacy of the imaging methods, the only possible answers were "Yes" or "No" and the response was mandatory to keep responding the questionnaire. However, there should be a third option of answer: "No answer" or the answers should not be mandatory to next question since not all respondents would have experience with all the three sectional image methods. This may have overestimated the positive responses of adequacy. Three respondents mentioned this subject when they were required to point out if they have experienced any difficulties completing the questionnaire.

In summary, this study suggests that TMJ sectional imaging assessment and diagnosis criteria as part of the standardization of

researches using the RDC/TMD established by Ahmad et al.7 are considered adequate in the worldwide community of radiologists' opinion. Although some adjustments are suggested by a few radiologists and/or researchers, they are in an attempt to improve the criteria. Consequently, a great diffusion of this publication was achieved and this may facilitate the development of studies, such as clinical trials, involving higher levels of diagnostic efficacy, where the socio-economic impact of these expensive imaging tests can be investigated.

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Figure 1 – First original table as published by Ahmad et al. for assessment of TMJ osseous tissues using panoramic, CT and MRI (Ahmad M, Hollender L, Anderson Q, Kartha K, Ohrbach R, Truelove EL et al. Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:844-60). With kind permission from Mosby, Elsevier Inc.

Table II. Osseous diagnoses for the TMJ from panoramic radiographs, computerized tomography, and magnetic resonance imaging. (Scoring options are A, B, or C as in the table below)

A. No osteoarthritis
  i. Normal relative size of the condylar head; and
  ii. No subcortical sclerosis or articular surface flattening; and
  iii. No deformation due to subcortical cyst, surface erosion, osteophyte, or generalized sclerosis.

B. Indeterminate for osteoarthritis
  i. Normal relative size of the condylar head; and
  ii. Subcortical sclerosis with/without articular surface flattening; or
  iii. Articular surface flattening with/without subcortical sclerosis; and
  iv. No deformation due to subcortical cyst, surface erosion, osteophyte, or generalized sclerosis.

C. Osteoarthritis
  i. Deformation due to subcortical cyst, surface erosion, osteophyte, or generalized sclerosis.

Figure 2 – Second original table as published by Ahmad et al. for diagnosis of TMJ osseous tissues using panoramic, CT and MRI (Ahmad M, Hollender L, Anderson Q, Kartha K, Ohrbach R, Truelove EL et al. Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:844-60). With kind permission from Mosby, Elsevier Inc.

Table III. Nonosseous component assessment criteria using magnetic resonance imaging

Scoring option	*Scoring criteria*
Disc position: closed-mouth sagittal and axially corrected coronal views (score Yes/No for each criteria)	Normal disc position i. In the sagittal plane, relative to the superior aspect of the condyle, the border between the low signal of the disc and the high signal of the retrodiscal tissue is located between the 11:30 and 12:30 clock positions;[85] and ii. In the sagittal plane, the intermediate zone is located between the anterior-superior aspect of the condyle and the posterior-inferior aspect of the articular eminence; and iii. In the oblique coronal plane, the disc is centered between the condyle and eminence in the medial, central, and lateral parts. Indeterminate i. In the sagittal plane, relative to the superior aspect of the condyle, the low signal of the disc and the high signal of the retrodiscal tissue are located anterior to the 11:30 position,[85] but the condyle contacts the intermediate zone located between the anterior-superior aspect of the condyle and the posterior-inferior aspect of the articular eminence; or ii. In the sagittal plane, relative to the superior aspect of the condyle, the low signal of the disc and the high signal of the retrodiscal tissue are located between the 11:30 and 12:30 clock positions,[85] but the intermediate zone of the disc is located anterior to the condyle; and iii. In the axially corrected coronal plane, the disc is positioned between the condyle and eminence in the medial, central, and lateral parts. Disc displacement i. In the sagittal plane, relative to the superior aspect of the condyle, the low signal of the disc and the high signal of the retrodiscal tissue are located anterior to the 11:30 clock position;[85] and ii. In the sagittal plane, the intermediate zone of the disc is located anterior to the condyle; or iii. In the axially corrected coronal plane, the disc is not centered between the condyle and eminence in either the medial or the lateral parts. Disc not visible: Neither signal intensity nor outlines make it possible to define a structure as the disc.
Disc position: open-mouth sagittal views (score Yes/No for each criteria)	Normal disc position: The intermediate zone is located between the condyle and the articular eminence. Persistent disc displacement: The intermediate zone is located anterior to the condylar head. Disc not visible: Neither signal intensity nor outlines make it possible to define a structure as the disc.
Disc shape: closed-mouth sagittal views (score Yes/No for each criteria)	Normal: The disc in the sagittal plane is biconcave. Deformed: All shapes other than biconcave in the sagittal plane. Disc not visible: Neither signal intensity nor outlines make it possible to define a shape of the disc.
Effusion: open- or closed-mouth sagittal views (score Yes/No for each criteria)	None: No bright signal in either joint space in the T2-weighted images. Slight effusion: A bright signal in either joint space that conforms to the contours of the disc, fossa/articular eminence, and/or condyle. Frank effusion: A bright signal in either joint space that extends beyond the osseous contours of the fossa/articular eminence and/or condyle and has a convex configuration in the anterior or posterior recesses.
Loose calcified bodies: closed-mouth sagittal views (score Yes/No)	Single or multiple discrete low signal intensity objects are present in the joint spaces, and are not attached to the condyle, fossa or eminence in any plane.

Figure 3 – Third original table as published by Ahmad et al.[13] for assessment of TMJ non-osseous tissues using MRI (Ahmad M, Hollender L, Anderson Q, Kartha K, Ohrbach R, Truelove EL et al. Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:844-60). With kind permission from Mosby, Elsevier Inc.

Table IV. Disc diagnosis for temporomandibular joint (TMJ) using magnetic resonance imaging (scoring options are A, B, C, D, or E)

A. Normal: Disc location is normal on closed- and open-mouth images.
B. Disc displacement with reduction: Disc location is displaced on closed-mouth images but normal in open-mouth images.
C. Disc displacement without reduction: Disc location is displaced on closed-mouth and open-mouth images.
D. Indeterminate: Disc location is not clearly normal or displaced in the closed-mouth position.
E. Disc not visible: Neither signal intensity nor outlines make it possible to define a structure as the disc in the closed-mouth and open-mouth views. If the images are of adequate quality in visualizing other structures in the TMJ, then this finding is interpreted to indicate a deterioration of the disc, which is associated with advanced disc pathology.

Figure 4– Fourth original table as published by Ahmad et al. for diagnosis of TMJ non-osseous tissues using MRI (Ahmad M, Hollender L, Anderson Q, Kartha K, Ohrbach R, Truelove EL et al. Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:844-60). With kind permission from Mosby, Elsevier Inc.

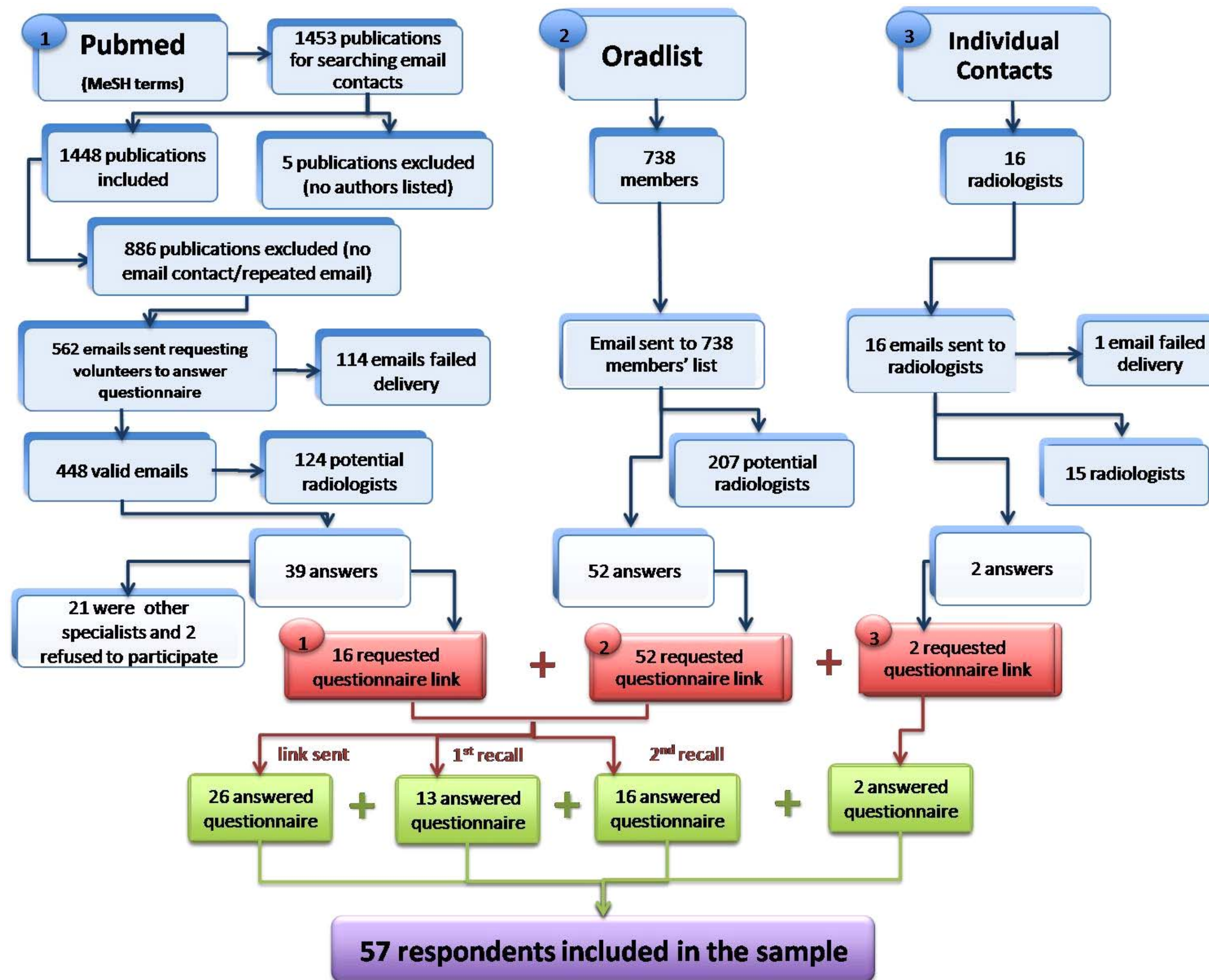
1
Pubmed
(MeSH terms)
1453 publications for searching email contacts
1448 publications included
5 publications excluded (no authors listed)
886 publications excluded (no email contact/repeated email)
562 emails sent requesting volunteers to answer questionnaire
114 emails failed delivery
448 valid emails
124 potential radiologists
39 answers
21 were other specialists and 2 refused to participate
1
16 requested questionnaire link
2
Oradlist
738 members
Email sent to 738 members' list
207 potential radiologists
52 answers
2
52 requested questionnaire link
3
Individual Contacts
16 radiologists
16 emails sent to radiologists
1 email failed delivery
15 radiologists
2 answers
3
2 requested questionnaire link
link sent
1st recall
2nd recall
26 answered questionnaire
13 answered questionnaire
16 answered questionnaire
2 answered questionnaire
57 respondents included in the sample

Figure 5- Flowchart of strategies adopted for accessing eligible population.

American Continent	N (%)
United States	11 (19,3)
Brazil	9 (15,8)
Canada	4 (7)
Chile	2 (3,5)
Argentina	1 (1,8)

Oceanian Contintent	N (%)
Australia	2 (3,5)

European Continent	N (%)
Turkey	4 (7)
United Kingdom	3 (5,3)
Finland	2 (3,5)
Sweden	2 (3,5)
Denmark	1 (1,8)
Greece	1 (1,8)
Germany	1 (1,8)
Belgium	1 (1,8)
Spain	1 (1,8)
Romania	1 (1,8)

Asian Contintent	N (%)
China	3 (5,3)
India	2 (3,5)
Saudi Arabia	1 (1,8)
Jordan	1 (1,8)
Israel	1 (1,8)
Korea	1 (1,8)
Japan	1 (1,8)
Kwait	1 (1,8)

African Contintent	N (%)
No respondents	-

Figure 6 - Distribution of radiologists respondents around the world according to working country (n=57).

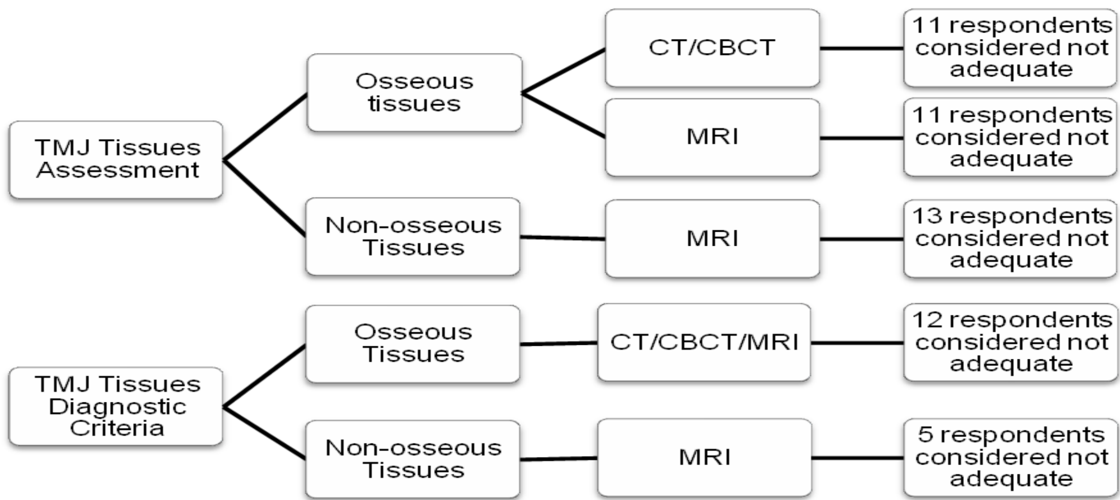

Figure 7 - Flowchart of respondents' opinion regarding to the adequacy of image criteria for TMJ tissues assessment and diagnostic criteria of TMJ tissues (osseous or non-osseous).

Table I. Demographics of survey respondents.

	n (total= 57)	%	
Gender			
Female	25	43,9	
Male	32	56,1	
Main field of activity			
Dentomaxillofacial Radiology	53	93	
General Radiology	4	7	
Years of practice in TMJ sectional imaging interpretation			
≤ 5 years	17	29,8	
> 5 ≤ 10 years	17	29,8	
> 10 years	23	40,4	
	Range	**Mean**	**Median**
Age (years)	25 - 74	46,6	46
Time working as a radiology specialist (years)	1 - 45	15,3	15
Hours per week currently working on image interpretation (hours/week)	1 - 50	22,6	24
Time of expertise in TMJ sectional imaging interpretation (years)	1 - 45	13	10
Hours per month spent in TMJ imaging interpretation (hours/month)	1 - 100	14	10
Hours per month spent in interpreting MR images of the TMJ (hours/month)	1 - 44	9,1	4
Hours per month spent in interpreting CT images of the TMJ (hours/month)	1 – 50	6,3	4,5
Hours per month spent in interpreting CBCT images of the TMJ (hours/month)	1 - 25	6,7	6

Table II. Percentage of valid responses of radiologists who considered the RDC/TMD criteria[13] adequate or not adequate for assessment and diagnosis of TMJ osseous and non-osseous tissues using CT, CBCT and MRI. The responses were according to their suggestions of changing or not the proposed criteria.

Table III. Respondent´s suggestions proposed to adequate the TMJ ASSESSMENT CRITERIA established by Ahmad et al.[35,36]

Image Technique	Scoring options	Insertion of new item			Modification of items			Elimination of items		
		Yes	No	% (no)	Yes	No	% (no)	Yes	No	% (no)
					TMJ OSSEOUS TISSUE ASSSESSMENT					
CT, CBCT (n=53)	Condylar head	4	49	93	5	48	91	0	53	100
	Fossa / eminence	2	51	96	1	52	98	0	53	100
	New scoring option	4	49	93	-	-	-	-	-	-
MRI (n=52)	Condylar head	6	46	89	5	47	91	1	51	98
	Condylar edema	5	47	91	0	52	100	0	52	100
	Fossa / eminence	1	51	98	1	51	98	0	52	100
	New scoring option	2	50	96	-	-	-	-	-	-
					TMJ NON-OSSEOUS TISSUE ASSSESSMENT					
MRI (n=51)	Disc position closed-mouth	2	49	96	7	44	87	1	50	98
	Disc position open-mouth	1	50	98	5	46	90	0	51	100
	Disc shape	0	51	100	3	48	94	0	51	100
	Effusion	1	50	98	2	49	96	0	51	100
	Loose calcified bodies	0	51	100	2	49	96	0	51	100
	New scoring option	2	49	96	-	-	-	-	-	-
					TMJ OSSEOUS TISSUE DIAGNOSIS					
CT, CBCT, MRI (n=52)	No osteoarthritis	1	51	98	6	46	89	2	50	96
	Indeterminate for osteoarthritis	2	50	96	7	45	87	3	49	95
	Osteoarthritis	4	48	93	6	46	89	0	52	100
	New scoring option	1	51	98	-	-	-	-	-	-
					TMJ NON-OSSEOUS TISSUE DIAGNOSIS					
MRI (n=50)	Normal	1	49	98	0	50	100	0	50	100
	Disc displacement with reduction	1	49	98	1	49	98	0	50	100
	Disc displacement without reduction									
	Indeterminate	1	49	98	0	50	100	0	50	100
	Disc not visible									
	New scoring option	1	49	98	0	50	100	1	49	98
		1	49	98	1	49	98	0	50	100
		2	48	96	-	-	-	-	-	-

NON-OSSEOUS	MRI	Disc position – Criteria for disc displacement with reduction; posterior, sideway and rotational displacements should be included. Also, coronal view in open-mouth was suggested to be included. Effusion – Frank effusion may help identification of disc perforation/rupture. Synovitis – High signal on T2 images, not as high as fluid, frequently seen in the inferior joint spaces. Rheumatoid arthritis – Synovial hypertrophy or changes on posterior disc attachment after gadolinium injection.	Disc position in closed mouth – to change the description of normal position from 11:30 and 12:30 to 10 and 12 o'clock or 11:30 to 1 o'clock or to "above the condyle". Also, to change the scoring criterion indeterminate disc position, from 11:30 to 11 position. Disc position in open mouth : Normal position should be considered between the articulating surfaces, instead of between the condyle and the articular eminence. In the persistent disc displacement, the anatomic structures to be used as reference should be posterior band located anteriorly to the condylar head, instead of intermediate zone. Disc shape – a deformed disc should be considered as other shapes than biconcave in the sagittal plane in the presence of disc displacement.	The scoring criteria "Disc position: closed-mouth – Indeterminate – In the sagittal plane, relative to the superior aspect of the condyle, the low signal of the disc and the high signal of the retrodiscal tissue are located anterior to the 11:30 position, but the condyle contacts the intermediate zone located between the anterior-superior aspect of the articular eminence."

Table IV. Respondent´s suggestions proposed to adequate the TMJ DIAGNOSIS CRITERIA established by Ahmad et al.7

Diagnostic imaging in the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) – Part 2: a technical protocol

TMJ tissue	Image Technique	Insertion of a new item	Items for modification	
OSSEOUS	CT, CBCT, MRI	Different terminology to MRI osseous characteristics than used for CT: low signal instead of sclerosis, the marrow signal of condyle and eminence are normally bright on T1-weighted MRI, abnormal marrow signal is either dark in T1-weighted images (condylar or eminence "sclerosis") or bright ("marrow edema") on T2-weighted images. Criteria for severe or extensive erosion of the condyle in the scoring option "Osteoarthritis" should be included. The narrowing of the joint space due to the deformation of the bony structures or bone-to-bone contact should be considered in the "Osteoarthritis" scoring option. Indistinct cortical outline of the condylar head may be included in the scoring option "Indeterminate for Osteoarthritis". "Mild osteoarthritis: subcortical sclerosis OR articular surface flattening".	Degenerative Joint Disease or Degenerative Change should be considered instead of term Osteoarthritis. Indeterminate for Osteoarthritis may be switched by Indeterminate Degenerative Joint Disease or Incipient Degenerative Change or Loading adaptation of the Joint or Adaptive Remodeling or Deviation in form.	One scori "No oste the cond The four s options r Osteoart condylar with/with "Articula subcortic due to su osteophy "Indetermi sclerosis flattening
NON-OSSEOUS	MRI	Sideways and rotational displacements: Disc not visible. May be normal, but very thin and with intermediate signal intensity and thus not clearly defined".	Instead of scoring option "e. Disc not visible", it should be used "e. Disc not visible in sagittal and coronal examination".	"d. Indeter normal c position"

for acquiring TMJ images should be included?

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Diagnostic imaging in the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) – Part 2: a technical protocol for acquiring TMJ images should be included?

ABSTRACT

Objective(s): To investigate the opinion of radiology specialists worldwide regarding the need of adding a minimal technical protocol for acquiring computed tomography (CT), cone-beam computed tomography (CBCT) and magnetic resonance (MR) images as part of Research Diagnostic Criteria for Temporomadibular Disorders (RDC/TMD). **Study design:** TMJ researchers, Oradlist members and individual contacts were invited by email as eligible population to contribute as volunteers to the study. Inclusion criteria required radiologists with experience interpreting TMJ sectional image. The link to the online questionnaire was sent to those who match the inclusion criteria. The questions were related to the need to include a minimal technical protocol for TMJ CT, CBCT and MRI acquisition as part of the RDC/TMD. If deemed necessary, the respondent should indicate which would be his/her suggestion protocol for acquisition of each sectional imaging. **Results:** Fifty-seven radiologists from different countries completed the questionnaire. Forty nine volunteers responded research tool and 81.6% of them considered necessary to include a minimal technical protocol for CT, CBCT and MRI acquisition as part of the RDC/TMD. **Conclusion:** This study suggests a greater need to include a minimal technical protocol for TMJ sectional image acquisition as part of RDC/TMD according to worldwide radiologists' opinion. A minimal image technical protocol is proposed.

KEYWORDS: temporomandibular joint disorders; diagnostic imaging; magnetic resonance imaging; tomography, x-ray computed; cone-beam computed tomography.

INTRODUCTION

Clinical practice should be guided on scientific evidence from research findings with appropriate methodologies and based on reliable and valid diagnostic criteria. This is of the utmost importance to increase the chances of successful treatment of temporomandibular disorders (TMD). Therefore, it is also the base of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)1 which was elaborated in order to standardize research in this subject.

Despite the diagnostic efficacy of imaging methods in temporomandibular joint disorders (TMJD) patient care be controversial,35,36 in some of these disorders such methods have been considered in order to confirm the extent or the stage of progression of known disease, to evaluate the effects of treatment or even for research purposes.35,36

If efficacy of any imaging examination is understood according to the hierarchical model proposed by Fryback and Thornbury,6 diagnostic accuracy is one of the lowest levels of diagnostic efficacy and it rests not just with technical adequacy but it is a complex interaction between the image and the person interpreting it. Thus, to reach higher levels of efficacy, imaging information should produce change in the referring physician's diagnostic thinking, an effect on the patient management/treatment outcomes or even societal costs and benefits.

The study conducted by Ahmad et al.7 was an important step to make RDC/TMD[1] more complete and improve its accuracy, since it established criteria for temporomandibular joint (TMJ) image assessment

using panoramic radiograph, computed tomography (CT) and magnetic resonance images (MRI). However, the complexity of diagnostic efficacy6 and the evolution and diversification of equipment and protocols for image acquisition35,36 are factors that may cause research biases.

Are the criteria proposed by Ahmad et al.7 considered adequate by the global community of radiology specialists? How can their technical adequacy be guaranteed in the context of RCD/TMD? The first question was approached in the first part of this study11 which revealed that adjustments to the criteria for TMJ sectional images assessment using RDC/TMD1 might not be necessary, as they are considered adequate for research purposes according to worldwide radiologists opinion. However, few adjustments could make it more effective.11 The second question is related to the goals of this current publication.

Different positions of the patient (open/closed mouth), quantity or thickness of slices in the sectional images, strength of magnetic field, among other parameters have been suggested to influence image interpretation.35,36

The aim of this study was therefore to investigate the opinions of radiology specialists from different parts of the world regarding to the need to add minimal technical criteria for acquiring sectional images of TMJ as part of the RDC/TMD.1

METHODS

This is the second part of a descriptive study which makes up a larger investigation undertaken after approval by the Research Ethics Committee of Federal University of Goias (UFG), Brazil.

Potential radiology specialists from different continents (American, European, Asian and Oceanian) were invited to participate in this study by an email and the following two notifications, from three ways: 1) TMJD Researchers with studies indexed in Pubmed database, after applying MeSH terms related to the research theme; 2) Oradlist members and 3) Individual contacts: the presidents of two leading international associations of Radiology - the International Society of Radiology (ISR) and the International Association of Dentomaxillofacial Radiology (IADMFR) and a few radiologists well known by the research group.

Radiologists, who replied the invitation email, matched the inclusion criteria (experienced in the assessment of TMJ sectional images) and agreed to answer the questionnaire in English, made up the sample.

Data collection was performed by using a self-administered questionnaire, which was drawn up in English and made available on the internet, through the LimeSurvey 1.87+ tool (*LimeSurvey™, Free Software Foundation, Inc., Fa. Carsten Schmitz, Germany*). The questionnaire underwent the stages of review and pretest before being submitted for assessment by the radiology specialists. The link to the online questionnaire was sent only to those willing volunteers who responded to the invitation-email and matched the inclusion criteria. Acceptance of the informed consent linked to the data collection tool was a prerequisite for answering to it.

The online research tool was divided into three parts. Parts I and

II, related to "Identification" and "Adequacy of imaging assessment criteria", respectively, composed the first part of this study.11 Part III of questionnaire comprised open and closed questions about "The need to add technical criteria for acquiring images using RDC/TMD" where respondents were asked about the need to include or not a minimal technical protocol for TMJ sectional images acquisition as part of the RDC/TMD:

"Considering that diagnostic accuracy of any imaging examination is a complex interaction between the image and the person interpreting it and also that RDC/TMD proposed criteria is related only to the examiner. What is your opinion regarding include suggestions of a minimal technical protocol for acquiring TMJ images (CT, CBCT- Cone beam CT and MRI) as part of the RDC/TMD?"

When the participants answered the above question positively, they had the option to register their own suggestions of a minimal technical protocol for acquiring CT/CBCT and MRI :

"Would you suggest a minimal technical protocol for acquiring CT and CBCT images to evaluate TMJ?"

Patient Position: (Choose one of the following answers)

Closed mouth in occlusion (maximum intercuspal position)

Opened mouth to the maximum they can tolerate with a mouth-opening device

Both positions above

Other

No answer

If you consider different positions for each method (CT, CBCT) add your answer in the option "other".

Sectional views (CT) (Choose one of the following answers)

Axial, with sagittal and coronal reformatted views

Axial and direct sagittal imaging

Axial, direct sagittal and coronal imaging

Direct sagittal imaging only

Other

No answer

Other suggestions:

“Would you suggest a minimal technical protocol different from the below for acquiring MRI to evaluate the TMJ?"

Closed mouth position, Spin-echo, High field

Fast axial localizer

Oblique sagittal, axially corrected according to the long axis of the condyle, Proton Density (PD) or T1, bilateral

Oblique coronal, axially corrected according to the long axis of the condyle, Proton Density (PD) or T1, bilateral

Open mouth position, Spin-echo, High field

Fast axial localizer

Oblique sagittal, axially corrected according to the long axis of the condyle, Proton Density (PD) or T1, bilateral

Oblique sagittal, axially corrected according to the long axis of the condyle,T2, bilateral

The set of options for the technical protocol was presented based on literature. The possibility to add other suggestions by respondents for each technique was also offered through an open field for answers.

Panoramic radiograph was not included in the research tool and CBCT image assessment was added on it. The original criteria7 did not include CBCT.

The completion of each question from Parts II and III was mandatory to go forward.

In the last question of the questionnaire the respondent was asked if he/she had experienced any difficulties when completing it.

Responses were described in absolute and relative frequency and exported to the SPSS Statistics 17.0 Program (SPSS Inc., Chicago, IL, USA) by using the tool database. The unanswered questions were excluded from data analysis. Categorization of the open responses was undertaken after at least three authors have reached consensus.

RESULTS

Fifty seven radiologists answered the research tool making up the sample, from the 70 volunteering radiologists interested in participating who have requested the link to the questionnaire. Forty-nine percent of the sample (n=29) was obtained after the recalls.

Ninety three percent of respondents (n=53) were Dentomaxillofacial Radiologists, aging from 25-74 years-old (mean age 46.6 years), with 1-45 years of experience as radiologists (mean=15.3 years, median=15 years, 1-45 years range) and working in TMJ sectional imaging interpretation (mean=13 years, median=10 years, 1-45 years range). Four general radiologists answered the questionnaire.

The full results of the strategies adopted for accessing eligible population and the relative frequency of the subjects' demographic characteristics details were presented in another publication as part I of this study.11

Adding technical criteria for TMJ images acquisition in the RDC/TMD

This part of questionnaire was answered by 49 participants (86%). The inclusion of a minimal technical protocol for acquiring TMJ sectional

images (CT, CBCT and MRI) as part of the RDC/TMD is considered necessary by 81.6% of respondents (n=40). From this, 90% (n=36*)* suggested establishing the inclusion of a minimal technical protocol for acquiring CT/CBCT images of TMJ and 81.6% (n=40) for MRI.

Respondent's opinion regarding the need to include a minimal technical protocol for image acquisition as part of RDC/TMD is shown in **Table I**.

A technical protocol for TMJ CT, CBCT and MRI to be included in the RDC/TMD[1] is suggested on **Figure 1**.

DISCUSSION

This study reveals that a strong majority of the specialists who answered the research tool not only agreed with the need to include minimal technical criteria for acquiring TMJ sectional images (CT, CBCT and MRI) as part of the RDC/TMD1 (81.6%), but also gave their suggestions (74 - 81.6%) for the construction of this guide.

A world-known definition about protocol in the context of science and medicine is that it is a formal set of rules and procedures to be followed during a particular research experiment, course of treatment, etc. This may lead to the understanding that this study aims to establish a "technical package" for all cases, restricting technical standards that should be dictated by various clinical conditions (signs, symptoms, treatment in progress, health history of each patient, etc.). Clinically, choice of which TMJD patients would benefit from radiological examination must be based on individual selection criteria; imaging must improve treatment planning and prognosis to be warranted.35,36

The present research aims to filter a minimal set of crucial technical parameters that could ensure minimal acceptable technical efficacy of the diagnostic imaging method, as a complementary examination in the TMJD diagnosis. Our study may collaborate with the process of review and validation in which the RDC/TMD[1] is underwent.

The credibility of results obtained from the selected sample is ensured by the inclusion criteria and demographic data obtained.

Blesser and Ozonoff13 proposed a model for the diagnostic process, which was modified by Rohlin et al.14 This model consists of three distinct phases: (1) psychophysical phase, includes the examination technique and the human visual system; (2) psychological phase, is the

higher unconscious cognitive processes organizing the image into percepts and (3) nosological phase which is the intellectual processes resulting in a diagnosis. Thus, any technical inadequacy of the images (psychophysical phase) that result in the lack of useful information will adversely affect the performance of radiologists, the diagnosis and treatment of patients. Likewise, the cognitive disability of the radiologist may generate nosological errors. These errors determine a misinterpretation of the information perceived which could be associated with inexperience of the radiologist. In the first example, it is clear the importance of establishing a minimal technical protocol to avoid psychophysical errors in the diagnostic process. In the second, it is highlighted the importance of time of professional experience. There is a deficiency of studies of the influence of professional experience in the specific context of TMJD imaging diagnosis, but other studies35,36 show that radiologists' interpretations of screening mammograms improve during their first few years of practice and continue to improve throughout much of their careers. The mean time of experience on TMJ sectional imaging interpretation of the respondents was more than ten years.

Two reasons are among those that could explain the higher number of dentomaxillofacial radiologists (n=53) making up the sample: the majority of respondents was derived from the Oradlist, which is a list for people with interest in oral and maxillofacial radiology and because most of respondents live in countries in which oral and maxillofacial radiology is recognized as a formal specialty.16 Despite the medical/general radiology have a large number of practitioners worldwide, those professionals may not be familiar with oral and maxillofacial field, and there was a lesser chance of having professional with experience in interpretation of TMJ sectional

images.

If we consider all those who answered the online questionnaire (n=57), over 80% have done it completely (n=49), which means they answered Part III, related to this research. We believe that the eight respondents (14%) who did not answer the questionnaire fully may have had experienced some difficulties to do it. One difficulty that maybe has occurred was regarding to research tool bias. The respondent had to mandatory answer questions of Part II to reach Part III. The Part II questioned the respondent about their experience with CT/CBCT and MRI. However, not all respondents would have experience with all the three sectional image methods at the same time. Thus, some of them may have given up.

TMJ sectional image technical protocol

In the context of any imaging methods, technical aspects can be related to the equipment/parameters and to the patient, which may influence image interpretation. Noise, spatial and contrast resolution, and the detector quantum efficiency are some technical aspects of particular interest in characterizing CT systems. Noise is fundamentally related to image quality and is a function of dose, tissue transmissivity, and voxel size.17 Clinical conditions of the patient are determinant not only of the prescription and type of imaging examination but also of the combination of technical parameters. Slice or reformatted planes arrangements, sections thickness, mouth position and image type (e.g. with bone filter, T1, T2, proton-density [PD]) are the main parameters that would compromise imaging information depending on patient signs and symptoms. Anatomical body aspects also influence in the selection parameters.35,36

The selection of the parameters that composed the research tool was based on the literature findings.35,36 Overall, there was a high acceptance of those parameters presented as a starting point since a few different suggestions were posted.

TMJ CT/CBCT technical protocol

Half of the respondents suggested that the protocol should include both open and closed mouth positions for TMJ tomography. This recommendation may have been made not necessarily to be conducted simultaneously and should be viewed with caution. Whereas CT remains the image of choice for assessing osseous tissues, axial views in combination with their corresponding coronal and sagittal reconstructions has been suggested as more accurate.35,36 The direct coronal and sagittal scans have been claimed as those that give the most detailed images, but require additional radiation dose, time and cost. Furthermore, it is impossible for some patients to bend their necks sufficiently to obtain direct images.[10]

No evidence that conventional tomography or CBCT is inferior to CT has been presented in the literature, and choice of imaging technique must depend on available equipment.35,36

"Considering the radiation dosage of the patients, conventional radiographic examination should go first for the most patients with TMD. CT, CBCT and MRI only be performed for the patients who have to be examined by this modalities base on the conventional radiographic findings or by clinical evidence". This comment is consistent with some published studies,35,36 which recommend panoramic radiography as screening method for TMJD. The results of Ahmad et al[7] showed that panoramic radiography had poor reliability and low sensitivity, compared with CT, for detecting TMJ-related osseous changes. These findings suggest that

this imaging modality has limited utility for assessing the TMJ.[7]

CBCT might prove to be a cost- and radiation dose-effective alternative to CT.35,36 CBCT is an accurate tool for analyzing mandibular condyle bone lesions, with the multiplanar reformatted (MPR) protocol showing slightly better results than the sagittal plus coronal slices throughout the longitudinal axis CT.[22] CBCT examinations raise the issue of just which area of the anatomy should be included in a study and it has vulnerability to increased scatter and therefore inaccurate representation of material density, compared to planning CT. The field of view (FOV) should be small to maximize spatial resolution and large enough to avoid the truncation of scattering material, particularly when imaging with a full-fan mode.[23] One of the respondents suggested "…*a full FOV scan, which includes the jaw and cranial base when the patient is in the closed mouth position, so that dental abnormalities and no-TMJ abnormalities which can mimic TMJ dysfunction can be ruled out*". According to accepted radiologic principles, the physical extent of the examination should be based on the patient's signs and symptoms.24

CT/CBCT image resolution is related to the size of the volumetric picture element selected (Voxel). A sectional image has a defined thickness and is composed of a matrix of voxels of identical size. One of the suggestions from respondents highlighted this point: *"open mouth position with no effort, minimal radiation dose, intercuspal position without clenching, with the best voxel available"*.

TMJ MRI technical protocol

Although high specificity (84-98%) was obtained with MRI, this modality showed relatively low sensitivity (30-82%) for detecting osseous abnormalities of the TMJ. The value of MRI for the detection of TMJ osseous

abnormalities is considered to be limited.[7,35,36]

MRI is the modality of choice for non-invasive imaging of TMJ, presenting excellent reliability for assessing disc position and good reliability for detecting effusions.[7]At present, it is therefore impossible to draw any conclusion about when the results of the MRI examination will result in a better treatment outcome for the TMD patients.[35,36]

The fact that half of respondents agreed with the MRI technical parameters proposed in the online questionnaire may reflect a consensus of the specialists community with what has been proposed in the literature, since the selection of these parameters was based on it. Additional suggestions were varied and mostly related to changes in specific parameters within the set suggested in the research tool.

"The use of TMJ surface coils should be specified. Minimal Tesla rating should also be noted". Experts have been using surface coils widely because it has become evident that spatial resolution and improved signal-to-noise ratio (SNR) are more advantageous than the other coils. However, it must be noted that it is sometimes difficult to visualize soft tissues in MR images because of the inhomogeneous sensitivity of these surface coils. The correction of the inhomogeneous sensitivity of the surface coil is necessary in order to compare the signal intensity in TMJ tissues.35,36 With the use of dual-surface-coil receivers,29 bilateral imaging is rapidly performed and was proposed as a routine clinical procedure. MR imaging has shown that the occurrence of bilateral abnormalities in patients with internal TMJ derangement is in the range of 60% to 70%.30

Subjective ratings of MR images obtained at different field strengths have suggested that systems with higher field strength provide

superior image quality. The protocol used on a high field system has been given with state-of-the-art MR technology,[31] but of course it must be adjusted depending on the type of equipment available. A highly significant difference in the perceptibility of disc shape and position was obtained when comparable examination sequences and identical resolution of 3.0 T MRI were compared with the ones from 1.5 T.32

"…What is most crucial in MR, CT and CBCT imaging is according to my experience how the slice or reformatted planes are arranged and the section thickness which should be maximum 3mm. If these criteria are met - then there are many different ways and settings to achieve good images."

*"…*Usually we don´t obtain a new localizer after the opening of the mouth, providing that patient doesn´t move his head…"

Sagittal and coronal MRI obtained by both methods oblique planes oriented according to the individual angle of the mandibular condyle (oblique images) and the true anatomic sagittal and coronal planes (orthogonal images) were compared for image quality of the disc by Musgrave et al.[33] In more than half of the patients (n=21) the oblique images demonstrated the anatomy of the disc better than the orthogonal images. Oblique images are therefore recommended. A new axial localizer in open mouth position is important to obtain the sagittal or coronal images of the condyle-disc complex, since it rotates and translates forward to allow jaw movement. Planning sagittal and coronal open mouth images with the closed mouth axial localizer may incur in the error of not getting the image of the mentioned complex.

The ability of MR imaging with thinner sections to reveal more anatomic details should result in improved diagnostic accuracy. The depiction of the disc, trabecular pattern, and cortex of the condyle has been

shown to be better on coronal 1.5-mm images than on 3.0-mm images, and 1.5-mm sagittal images for depiction of the trabecular pattern of the condyle than the 3.0-mm images.31

"*Fat saturation Spin-Echo PD or T2 sequences could be useful due his high sensitivity to depict bone edema (condyle...) and joint fluid.*"

"I would suggest taking the T2-weighted images obligatory with fat suppression, since this would show the joint effusion much better..."

Varied suggestions were made regarding to jaw positions, associating them or not with T2 sequence, but none of the respondents have considered closed mouth or open mouth individually. Based on the studies systematically reviewed by Limchaichana, Petersson and Rohlin,35,36 T1 or proton-density sequences should be used in combination with T2 images. T2-weighted MRI can make a significant diagnostic contribution by demonstrating inflammatory reactions such as joint effusion and marrow edema.34 Fat-suppression and magnetization-transfer contrast techniques may be applied for improved detection of contrast enhancement and better definition of the disc.[34] For best demonstration of anatomy, imaging should be performed in both sagittal and coronal planes, while to assess condylar mobility open and closed mouth images are needed.[8] Spin echo is the most frequent pulse sequence used for TMJ MR imaging and faster protocols has been developed with new pulse sequences, reducing length of examination time without compromising image quality.[8]

"I believe that dynamic MRI-studies with some real-time technique are very important, since they can show better a slight anterior displacement of the disc during the opening or protrusion of the jaw as the disc will usually replace in the course of the opening movement and can be better evaluated."

"Sagittal Gradient echo sequences can be used for semi-dynamic imaging and interpreting of the TMJ-movement especially in 3T machines and can sometimes replace the

open mouth view"

Many efforts have been done to improve dynamic MRI techniques, since pseudodynamic or Cine-MRI differs from the natural opening of the TMJ.35,36 ''Real-time MRI'' refers to the acquisition reconstruction, and display of magnetic resonance images without any unnecessary or even detectable delay. In preliminary applications to healthy volunteers, real-time radial FLASH MRI visualized continuous movements of the temporomandibular joint during voluntary opening and closing of the mouth at high spatial resolution.37

In conclusion, this study suggests a greater need to include a minimal technical protocol for the acquisition of TMJ sectional images as part of the standardization protocol of studies using the RDC/TMD according to worldwide radiologists' opinion, increasing its effectiveness. It also gave the support to set a minimal image technical protocol as a suggestion to be included in the RDC/TMD.1 Consequently, it may contribute to the development of studies involving higher levels of efficacy, where the socio-economic impact of these expensive imaging tests can be investigated.

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Table I. Frequency of TMJ imaging technical parameters suggested by respondents to be included as part of RDC/TMD (the criteria proposed in the research tool are bold. All the other were new suggestions from respondents).

Image Technique	Technical Parameters	Inclusion in the minimal technical protocol for RDC/TMD		
		NO	YES	% (inclusion)
CT, CBCT (n=36/49)	**Patient Position** (n=36)			
	Closed mouth in occlusion (maximum intercuspal position)	23	13	36
	Opened mouth to the maximum they can tolerate with a mouth-opening device	35	1	3
	Both positions above on CT and CBCT	18	18	50
	Both positions above on CBCT only	35	1	3
	Both positions above and an intermediate position with a slight opening	35	1	3
	Closed mouth in occlusion without clenching with best voxel available and opened mouth with no effort, minimum radiation dose	35	1	3
	Sectional views (n=36)			
	Axial, with sagittal and coronal reformatted views	9	27	75
	Axial and direct sagittal imaging	35	1	3
	Axial, direct sagittal and coronal imaging	30	6	17
	Direct sagittal imaging only	36	0	0
	Axial, with sagittal and coronal reformatted views corrected to the long axis of the condylar head	35	1	3
	Full field of view on CBCT scan from cranial base to mandibular base, closed mouth position	35	1	3
	Filters when the presence of erosion or cystic lesion	35	1	3
MRI (n=40/49)	**Proposed parameters in the research tool** (n=[illegible])			
	• **Closed mouth position, Spin-echo, High field** **o Fast axial localizer** **o Oblique sagittal, axially corrected according to the long axis of the condyle, Proton Density (PD) or T1, bilateral** **o Oblique coronal, axially corrected according to the long axis of the condyle, Proton Density (PD) or T1, bilateral** • **Open mouth position, Spin-echo, High field** **o Fast axial localizer** **o Oblique sagittal, axially corrected according to the long axis of the condyle, Proton Density (PD) or T1, bilateral** **o Oblique sagittal, axially corrected according to the long axis of the condyle, T2, bilateral**	20	20	50
	Other suggestions different from proposed (n=20)			
	T2 or Fast spin-echo T2 in closed mouth position only	-	4	10
	Closed mouth and intermediate position in T2	-	1	2.5
	Slightly opened mouth coronal T2	-	1	2.5
	Opened mouth position with the aid of a device (bite block or similar)	-	1	2.5
	Opened mouth coronal T2	-	1	2.5

CT

Patient Position

Closed mouth in occlusion (maximum intercuspal position, without clenching)

Open mouth to the maximum they can tolerate, without effort, with the aid of a mouth-opening device

* *The acquisition of image on each or both positions above will depend upon clinical indication.*

Sectional views

Axial, with corrected sagittal and coronal reformatted views

CBCT

Patient Position

Closed mouth in occlusion (maximum intercuspal position, without clenching) with best voxel available and minimal radiation dose

Open mouth to the maximum they can tolerate, without effort, with the aid of a mouth-opening device, and minimal radiation dose

* *The acquisition of image on each or both positions above will depend upon clinical indication.*

Sectional views

Axial, with corrected sagittal and coronal reformatted views

Field of view

From cranial base to mandibular base or the smallest field of view that covers TMJ depending on clinical indication

MRI

TMJ surface coils with 7inches minimal diameter

Closed mouth position, Spin-echo, High field

Fast axial localizer

Oblique sagittal, axially corrected according to the long axis of the condyle, slice thickness not thicker than 3mm, Proton Density (PD) or T1, bilateral

Oblique coronal, axially corrected according to the long axis of the condyle, slice thickness not thicker than 3mm, Proton Density (PD) or T1, bilateral

Open mouth position, with the aid of a mouth-opening device, Spin-echo, High field

Fast axial localizer

Oblique sagittal, axially corrected according to the long axis of the condyle, slice thickness not thicker than 3mm, Proton Density (PD) or T1, bilateral

Oblique sagittal, axially corrected according to the long axis of the condyle, slice thickness not thicker than 3mm ,T2 with fat satūration, bilateral

Figure 1. Minimal technical protocol suggested for being included in the RDC/TMD.5

CONSIDERAÇÕES FINAIS

Os resultados do presente estudo sugerem que ajustes nos critérios para interpretação de imagens seccionais da ATM como parte do protocolo de normatização das pesquisas que utilizam o RDC/TMD podem não ser necessários de acordo com a opinião da comunidade mundial de radiologistas. Entretanto, pequenos ajustes poderiam tornar os referidos critérios mais adequados e a inclusão de um protocolo técnico mínimo para a aquisição das referidas imagens é considerada necessária. Como consequência, a versão adaptada dos critérios estabelecidos por Ahmad et al (2009) poderá facilitar o desenvolvimento de estudos envolvendo níveis mais elevados de eficácia, em que o impacto sócio-econômico desses exames de alto custo possa ser investigado.

APÊNDICES

Apêndice 1 – TCLE

Apêndice 2 – Instrumento de pesquisa original em ingles

APÊNDICE 1 - TCLE

TMJ Imaging RDC/TMD

INFORMED CONSENT FORM

You are being invited to participate as a volunteer in this research. To collect the data a questionnaire containing 29 open and closed questions will be used. We guarantee the confidentiality of the information provided and all the information contained in the questionnaire will be the exclusive property of the Dentistry Schools of Federal University of Goias, Brazil - UFG and Malmö University, Malmo, Sweden that may use the results obtained for teaching and scientific publications while respecting professional confidentiality and ethics.

There are no direct benefits from your participation in this study but it is hoped that the results will serve as an important instrument for standardising the clinical research on temporomandibular disorders (TMD).

We appreciate your cooperation!

Luciana Pimenta e Silva Machado – UFG,Brazil
Rejane Faria Ribeiro-Rotta – UFG, Brazil
Arne Petersson – Malmo University, Sweden

☐ I agree to participate as a subject in the study 'Research Diagnostic Criteria for temporomandibular disorders (RDC/TMD): adequacy, effectiveness and acceptability in interpreting images. I have been duly informed about the research. The procedures involved, as well as the possible risks and benefits arising out of my participation, have been clarified. I have been assured that I can withdraw my consent at any time without penalty

☐ I do not agree to participate as a subject in the study

Next >>

FINISHED:
Please, click the SUBMIT button to validate your answers. If you prefer to review any question, click on PREVIOUS button. Don't forget to S
We would like to thank you for your participation in this research. Your opinion is very important.

APÊNDICE 2 – Instrumento de pesquisa original em inglês

PART I. IDENTIFICATION

A. Gender: 1 ( ) Male 2 ( ) Female

B. Age: _______ years (Only numbers may be entered in this field)

C. Working Country: ________

D. Main field of activity: (Choose one of the following answers)
1 ( ) Dentomaxillofacial Radiology 2 ( ) General Radiology
3 ( ) Other (abrir campo para resposta aberta)

E. How long have you been working as a radiology specialist? (Only numbers may be entered in this field)
________ years

F. How many times per week do currently you work on radiology (interpreting images)? (Only numbers may be entered in this field)
_______ hours per week
Please do not answer if you do not work on radiology anymore.

G. How long have you been interpreting TMJ sectional images? (Only numbers may be entered in this field)
_______ years
Please do not answer if you do not work on radiology anymore.
(This response leads you to the screen acknowledging your participation in this research)

H. How much time do you spend interpreting TMJ images? (Only numbers may be entered in this field)
_______ hours per month

I. In your professional activity, how long do you spend interpreting TMJ images on Computed Tomography? (Only numbers may be entered in this field)
_______ hours per month

J. In your professional activity, how long do you spend interpreting TMJ images using Cone Beam Computed Tomography? (Only numbers may be entered in this field)
_______ hours per month

K. In your professional activity, how long do you spend interpreting TMJ images on Magnetic Resonance Images? (Only numbers may be entered in this field)
_______ hours per month

PART II. ADEQUACY, EFFECTIVENESS AND ACCEPTABILITY OF CRITERIA FOR ANALYSING IMAGES

To answer the following questions, you will use the table below.

Scoring option	*Scoring criteria*
a. Condylar head: (score Yes/No for each of the 11 criteria)	1. Condylar hypoplasia: Condylar morphology is normal but the size is small from all dimensions. This is associated with either an increase in the joint space in a normal articular fossa, or a small articular fossa. 2. Condylar hyperplasia: Condylar morphology is normal but the size is large in all dimensions. This is associated with either lack of joint space in a normal articular fossa or an enlarged articular fossa to accommodate the large condyle. 3. Articular surface flattening: A loss of the rounded contour of the surface. 4. Subcortical sclerosis: Any increased thickness of the cortical plate in the load-bearing areas relative to the adjacent nonload-bearing areas. With MRI, this is identified as low signal intensity in bone marrow on proton density and T2 study. 5. Subcortical cyst: A cavity below the articular surface that deviates from normal marrow pattern. 6. Surface erosion: Loss of continuity of articular cortex. 7. Osteophyte: Marginal hypertrophy with sclerotic borders and exophytic angular formation of osseous tissue arising from the surface. 8. Generalized sclerosis: No clear trabecular orientation with no delineation between the cortical layer and the trabecular bone that extends throughout the condylar head. 9. Loose joint body: A well defined calcified structure(s) that is not continuous with the disc or osseous structures of the joint. With MRI, this is identified as low and/or high signal on proton and T2 study. 10. Deviation in form: Condylar deviation in form is defined as a departure from normal shape, such as concavity in the outline of the cortical plate, and not attributable to flattening, erosive changes, osteophytes, hyper or hypoplasia. 11. Bony ankylosis: Continuous osseous structure between the condyle and temporal bone associated with no discernable joint space and no translation of the condyle in the open mouth views.
b. Fossa/eminence (score Yes/No for each of the 3 criteria).	1. Articular surface flattening: A loss of the rounded contour of the surface. 2. Subcortical sclerosis: Any increased thickness of the cortical plate in the load-bearing areas relative to the adjacent nonload-bearing areas. With MRI, this is identified as low signal intensity in bone marrow on proton and T2 study. 3. Surface erosion: Loss of continuity of cortical margin.

L_1. In your opinion, are the criteria presented in the table above adequate for evaluating TMJ **osseous tissues** in **images using** CT and CBCT?

1. ( ) No (essa resposta leva à questão L_2)
2. ( ) Yes (essa resposta leva à questão M_1)

L_2. Would you suggest insertion of new item(s)? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão L_3)
2. ( ) Yes, but I do not have suggestion (essa resposta leva à questão L_3)
3. ( ) Yes, my suggestion(s) is(are):

(abrir campo para resposta aberta) (Somente seguir para questão L_3 se o participante digitar a sugestão)

L_3. Would you suggest modification of the content of existing items/criteria. (As you mark the item/criteria to be modified, a field for response will appear. More than one option may be marked)

1. ( ) No (essa resposta leva à questão L_4)
2. ( ) Yes. Which one(s)?

( ) a.1. ( ) - field for response
( ) a.2. ( ) - field for response
( ) a.3. ( ) - field for response
( ) a.4. ( ) - field for response
( ) a.5. ( ) - field for response
( ) a.6. ( ) - field for response
( ) a.7. ( ) - field for response
( ) a.8. ( ) - field for response
( ) a.9. ( ) - field for response
( ) a.10. ( ) - field for response
( ) a.11. ( ) - field for response
( ) b.1. ( ) - field for response
( ) b.2. ( ) - field for response
( ) b.3. ( ) - field for response

(Somente seguir para questão L_4, clicar em alguma resposta no caso de Yes)

L_4. Would you suggest elimination of items? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão L_5)
2. ( ) Yes. Which one(s)?

( ) a.1. ( ) a.7. ( ) b.1.
( ) a.2. ( ) a.8. ( ) b.2.
( ) a.3. ( ) a.9. ( ) b.3.
( ) a.4. ( ) a.10.
( ) a.5. ( ) a.11.
( ) a.6.

L_5. Do you have other suggestion different from insertion, modification or elimination of item in the above set of criteria?

1. ( ) No (essa resposta leva à questão M_1)
2. ( ) Yes. ( ) - field for response

To answer the following questions, you will use the table below.

Scoring option	*Scoring criteria*
a. Condylar head: (score Yes/No for each of the 11 criteria)	1. Condylar hypoplasia: Condylar morphology is normal but the size is small from all dimensions. This is associated with either an increase in the joint space in a normal articular fossa, or a small articular fossa. 2. Condylar hyperplasia: Condylar morphology is normal but the size is large in all dimensions. This is associated with either lack of joint space in a normal articular fossa or an enlarged articular fossa to accommodate the large condyle. 3. Articular surface flattening: A loss of the rounded contour of the surface. 4. Subcortical sclerosis: Any increased thickness of the cortical plate in the load-bearing areas relative to the adjacent nonload-bearing areas. With MRI, this is identified as low signal intensity in bone marrow on proton density and T2 study. 5. Subcortical cyst: A cavity below the articular surface that deviates from normal marrow pattern. 6. Surface erosion: Loss of continuity of articular cortex. 7. Osteophyte: Marginal hypertrophy with sclerotic borders and exophytic angular formation of osseous tissue arising from the surface. 8. Generalized sclerosis: No clear trabecular orientation with no delineation between the cortical layer and the trabecular bone that extends throughout the condylar head. 9. Loose joint body: A well defined calcified structure(s) that is not continuous with the disc or osseous structures of the joint. With MRI, this is identified as low and/or high signal on proton and T2 study. 10. Deviation in form: Condylar deviation in form is defined as a departure from normal shape, such as concavity in the outline of the cortical plate, and not attributable to flattening, erosive changes, osteophytes, hyper or hypoplasia. 11. Bony ankylosis: Continuous osseous structure between the condyle and temporal bone associated with no discernable joint space and no translation of the condyle in the open mouth views.
b. Fossa/eminence (score Yes/No for each of the 3 criteria).	1. Articular surface flattening: A loss of the rounded contour of the surface. 2. Subcortical sclerosis: Any increased thickness of the cortical plate in the load-bearing areas relative to the adjacent nonload-bearing areas. With MRI, this is identified as low signal intensity in bone marrow on proton and T2 study. 3. Surface erosion: Loss of continuity of cortical margin.
c. MRI only: (score Yes/No).	1. Condylar edema: Any high signal intensity within the bone marrow of the condyle present on T2 study.

M_1. In your opinion, are the criteria presented in the table above adequate for evaluating TMJ osseous tissues using MRI?

1. ( ) No (essa resposta leva à questão M_2)
2. ( ) Yes (essa resposta leva à questão N_1)

M_2. Would you suggest insertion of new item(s)? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão M_3)
2. ( ) Yes, but I do not have suggestion (essa resposta leva à questão M_3)
3. ( ) Yes, my suggestion(s) is(are):

(abrir campo para resposta aberta) (Somente seguir para questão M_3, se o participante digitar a

sugestão)

M_3. Would you suggest modification of the content of existing items/criteria. (As you mark the item/criteria to be modified, a field for response will appear. More than one option may be marked)

1. ( ) No (essa resposta leva à questão M_4)
2. ( ) Yes. Which one(s)?

( ) a.1. ( ) - field for response
( ) a.2. ( ) - field for response
( ) a.3. ( ) - field for response
( ) a.4. ( ) - field for response
( ) a.5. ( ) - field for response
( ) a.6. ( ) - field for response
( ) a.7. ( ) - field for response
( ) a.8. ( ) - field for response
( ) a.9. ( ) - field for response
( ) a.10. ( ) - field for response
( ) a.11. ( ) - field for response
( ) b.1. ( ) - field for response
( ) b.2. ( ) - field for response
( ) b.3. ( ) - field for response
( ) c. ( ) - field for response

(Somente seguir para questão M_4, clicar em alguma resposta)

M_4. Would you suggest elimination of items? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão M_5)
2. ( ) Yes. Which one(s)?

( ) a.1.	( ) a.7.	( ) b.1.	( ) c.
( ) a.2.	( ) a.8.	( ) b.2.	
( ) a.3.	( ) a.9.	( ) b.3.	
( ) a.4.	( ) a.10.		
( ) a.5.	( ) a.11.		
( ) a.6.			

M_5. Do you have other suggestion different from insertion, modification or elimination of item in the above set of criteria?

1. ( ) No (essa resposta leva à questão N_1)
2. ( ) Yes. ( ) - abrir campo para resposta aberta / open field for response

---

To answer the following questions, you will use the table below.

Scoring option	*Scoring criteria*
a. No osteoarthritis	i. Normal relative size of the condylar head; and ii. No subcortical sclerosis or articular surface flattening; and iii. No deformation due to subcortical cyst, surface erosion, osteophyte, or generalised sclerosis.
b. Indeterminate for osteoarthritis	i. Normal relative size of the condylar head; and ii. Subcortical sclerosis with/without articular surface flattening; or iii. Articular surface flattening with/without subcortical sclerosis; and iv. No deformation due to subcortical cyst, surface erosion, osteophyte, or generalised sclerosis.

c. . Osteoarthritis	i. Deformation due to subcortical cyst, surface erosion, osteophyte, or generalised sclerosis.

N_1. In your opinion, are the scores in the table above adequate for the osseous diagnosis of the TMJ using CT, CBCT and MR images? (the scoring options are a, b or c)

1. ( ) No (essa resposta leva à questão N_2)
2. ( ) Yes (essa resposta leva à questão O_1)

N_2. Would you suggest insertion of new item(s)? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão N_3)
2. ( ) Yes, but I do not have suggestion (essa resposta leva à questão N_3)
3. ( ) Yes, my suggestion(s) is(are):
   (abrir campo para resposta aberta)(Somente seguir para questão N_3, se o participante digitar a sugestão)

N_3. Would you suggest modification of the content of existing items/criteria. (As you mark the item/criteria to be modified, a field for response will appear. More than one option may be marked)

1. ( ) No (essa resposta leva à questão N_4)
2. ( ) Yes. Which one(s)?
   ( ) a.i. ( ) - field for response
   ( ) a.ii. ( ) - field for response
   ( ) a.iii. ( ) - field for response
   ( ) b.i. ( ) - field for response
   ( ) b.ii. ( ) - field for response
   ( ) b.iii. ( ) - field for response
   ( ) b.iv. ( ) - field for response
   ( ) c.i. ( ) - field for response
   (Somente seguir para questão N_4, clicar em alguma resposta)

N_4. Would you suggest elimination of items? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão N_5)
2. ( ) Yes. Which one(s)?

( ) a.i.	( ) b.i.	( ) c.i
( ) a.ii.	( ) b.ii.	
( ) a.iii.	( ) b.iii.	
	( ) b.iv.	

N_5. Do you have other suggestion different from insertion, modification or elimination of item in the above set of criteria?

1. ( ) No (essa resposta leva à questão O_1)
2. ( ) Yes. ( ) - field for response

To answer the following questions, regarding the interpretion of TMJ using MRI, you will use the table below.

Scoring option	*Scoring criteria*
a. Disc position: closed-mouth sagittal and axially corrected coronal views (score Yes/No for each criteria)	1. Normal disc position i. In the sagittal plane, relative to the superior aspect of the condyle, the border between the low signal of the disc and the high signal of the retrodiscal tissue is located between the 11:30 and 12:30 clock positions; and ii. In the sagittal plane, the intermediate zone is located between the anterior-superior aspect of the condyle and the posterior-inferior aspect of the articular eminence; and iii. In the oblique coronal plane, the disc is centered between the condyle and eminence in the medial, central, and lateral parts. 2. Indeterminate i. In the sagittal plane, relative to the superior aspect of the condyle, the low signal of the disc and the high signal of the retrodiscal tissue are located anterior to the 11:30 position, but the condyle contacts the intermediate zone located between the anterior-superior aspect of the condyle and the posterior-inferior aspect of the articular eminence; or ii. In the sagittal plane, relative to the superior aspect of the condyle, the low signal of the disc and the high signal of the retrodiscal tissue are located between the 11:30 and 12:30 clock positions, but the intermediate zone of the disc is located anterior to the condyle; and iii. In the axially corrected coronal plane, the disc is positioned between the condyle and eminence in the medial, central, and lateral parts. 3. Disc displacement i. In the sagittal plane, relative to the superior aspect of the condyle, the low signal of the disc and the high signal of the retrodiscal tissue are located anterior to the 11:30 clock position; and ii. In the sagittal plane, the intermediate zone of the disc is located anterior to the condyle; or iii. In the axially corrected coronal plane, the disc is not centred between the condyle and eminence in either the medial or the lateral parts. 4. Disc not visible: Neither signal intensity nor outlines make it possible to define a structure as the disc.
b. Disc position: open-mouth sagittal views (score Yes/No for each criteria)	1. Normal disc position: The intermediate zone is located between the condyle and the articular eminence. 2. Persistent disc displacement: The intermediate zone is located anterior to the condylar head. 3. Disc not visible: Neither signal intensity nor outlines make it possible to define a structure as the disc.
c. Disc shape: closed-mouth sagittal views (score Yes/No for each criteria)	1. Normal: The disc in the sagittal plane is biconcave. 2. Deformed: All shapes other than biconcave in the sagittal plane. 3. Disc not visible: Neither signal intensity nor outlines make it possible to define a shape of the disc.
d. Effusion: open- or closed-mouth sagittal views (score Yes/No for each criteria)	1. None: No bright signal in either joint space in the T2-weighted images. 2. Slight effusion: A bright signal in either joint space that conforms to the contours of the disc, fossa/articular eminence, and/or condyle. 3. Frank effusion: A bright signal in either joint space that extends beyond the osseous contours of the fossa/articular eminence and/or condyle and has a convex configuration in the anterior or posterior recesses.

e. Loose calcified bodies: closed-mouth sagittal views (score Yes/No)	1. Single or multiple discrete low-signal intensity objects are present in the joint spaces, and are not attached to the condyle, fossa or eminence in any plane.

O_1. In your opinion, are the criteria presented in the table above adequate for evaluating TMJ **non-osseous tissues** using MRI?

1. ( ) No (essa resposta leva à questão O_2)
2. ( ) Yes (essa resposta leva à questão P_1)

O_2. Would you suggest insertion of new item(s)? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão O_3)
2. ( ) Yes, but I do not have suggestion (essa resposta leva à questão O_3)
3. ( ) Yes, my suggestion(s) is(are):

(abrir campo para resposta aberta) (Somente seguir para questão O_3, se o participante digitar a sugestão)

O_3. Would you suggest modification of the content of existing items/criteria. (As you mark the item/criteria to be modified, a field for response will appear. More than one option may be marked)

1. ( ) No (essa resposta leva à questão O_4)
2. ( ) Yes. Which one(s)?

( ) a.1.i. ( ) - field for response
( ) a.1.ii. ( ) - field for response
( ) a.1.iii. ( ) - field for response
( ) a.2.i. ( ) - field for response
( ) a.2.ii. ( ) - field for response
( ) a.2.iii. ( ) - field for response
( ) a.3.i. ( ) - field for response
( ) a.3.ii. ( ) - field for response
( ) a.3.iii. ( ) - field for response
( ) a.4. ( ) - field for response
( ) b.1. ( ) - field for response
( ) b.2. ( ) - field for response
( ) b.3. ( ) - field for response
( ) c.1. ( ) - field for response
( ) c.2. ( ) - field for response
( ) c.3. ( ) - field for response
( ) d.1. ( ) - field for response
( ) d.2. ( ) - field for response
( ) d.3. ( ) - field for response
( ) e.1. ( ) - field for response

(Somente seguir para questão O_4, clicar em alguma resposta)

O_4. Would you suggest elimination of items? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão O_5)

2. ( ) Yes. Which one(s)?

( ) a.1.i	( ) a.3.i	( ) b.1	( ) c.1	( ) d.1	( ) e.1.
( ) a.1.ii	( ) a.3.ii	( ) b.2	( ) c.2	( ) d.2	
( ) a.1.iii	( ) a.3.iii	( ) b.3	( ) c.3	( ) d.3	
( ) a.2.i	( ) a.4				
( ) a.2.ii					
( ) a.2.iii					

O_5. Do you have other suggestion different from insertion, modification or elimination of item in the above set of criteria?

1. ( ) No (essa resposta leva à questão P_1)
2. ( ) Yes. ( ) - field for response

To answer the following questions, you will use the table below.

Scoring option	*Scoring criteria*
a. Normal	Normal: Disc location is normal on closed- and open-mouth images.
b. Disc displacement with reduction	Disc location is displaced on closed-mouth images but normal in open-mouth images.
c. Disc displacement without reduction	Disc location is displaced on closed-mouth and open-mouth images.
d. Indeterminate	Disc location is not clearly normal or displaced in the closed-mouth position.
e. Disc not visible	Neither signal intensity nor outlines make it possible to define a structure as the disc in the closed-mouth and open-mouth views. If the images are of adequate quality in visualising other structures in the TMJ, then this finding is interpreted to indicate a deterioration of the disc, which is associated with advanced disc pathology.

P_1. In your opinion, are the scores in the table below adequate for **diagnosing TMJ non-osseous tissues** using MRI (the scoring options are a, b, c, d **or** e)

1. ( ) No (essa resposta leva à questão P_2)
2. ( ) Yes (essa resposta leva à questão Q da parte III do questionário)

P_2. Would you suggest insertion of new item(s)? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão P_3)
2. ( ) Yes, but I do not have suggestion (essa resposta leva à questão P_3)
3. ( ) Yes, my suggestion(s) is(are):
   (abrir campo para resposta aberta) (Somente seguir para questão P_3, se o participante digitar a sugestão)

P_3. Would you suggest modification of the content of existing items/criteria. (As you mark the item/criteria to be modified, a field for response will appear. More than one option may be marked)

1. ( ) No (essa resposta leva à questão P_4)

2. ( ) Yes. Which one(s)?
( ) a. ( ) - field for response
( ) b. ( ) - field for response
( ) c. ( ) - field for response
( ) d. ( ) - field for response
( ) e. ( ) - field for response
(Somente seguir para questão $P_{4,}$ clicar em alguma resposta)

P_4. Would you suggest elimination of items? (More than one option may be marked)

1. ( ) No (essa resposta leva à questão P_5)
2. ( ) Yes. Which one(s)?
( ) a. ( ) b. ( ) c. ( ) d. ( ) e.

P_5. Do you have other suggestion different from insertion, modification or elimination of item in the above set of criteria?

1. ( ) No (essa resposta leva à questão Q da parte III do questionário)
2. ( ) Yes. ( ) - field for response

PART III. THE NEED TO ADD TECHNICAL CRITERIA FOR ACQUIRING IMAGES USING RDC/TMD

Q. Considering that diagnostic accuracy of any imaging examination is a complex interaction between the image and the person interpreting it and also that RDC/TMD proposed criteria related only to the examiner. What is your opinion regarding include suggestions of a minimum technical protocol for acquiring TMJ images (CT, CBCT and MRI) as part of the RDC/TMD?

1. ( ) It is not necessary (this response takes you to the screen for acknowledging your participation in this research) (essa resposta leva à questão T)
2. ( ) It should be included (essa resposta leva à questão R)

R. Would you suggest a minimal technical protocol for acquiring **CT and CBCT images** to evaluate TMJ?

1. ( ) Yes (essa resposta leva ao aparecimento das questões de R_1 a R_3)
2. ( ) No (essa resposta leva ao aparecimento das questões de S_1 a S_6)

R_1. ( ) Patient position. (Choose one of the following answers)

?: If you consider different positions for each method (CT, CBCT) add your answer in the option "other".

1. ( ) Closed mouth in occlusion (maximum intercuspal position)
2. ( ) Opened mouth to the maximum they can tolerate with a mouth-opening device
3. ( ) Both positions above
4. ( ) Other: ( ) (field for response)
5. ( ) No answer

R_2. Sectional views (CT): (Choose one of the following answers)

FINISHED:

Please, click the SUBMIT button to validate your answers. If you prefer to review any question, click on PREVIOUS button. Don't forget to SUBM
We would like to thank you for your participation in this research. Your opinion is very important.

[Exit and clear survey]

1. ( ) Axial, with sagittal and coronal reformatted views
2. ( ) Axial and direct sagittal imaging
3. ( ) Axial, direct sagittal and coronal imaging
4. ( ) Direct sagittal imaging only
5. ( ) Other: ( ) (field for response)
6. ( ) No answer

R_3. ( ) Other suggestions: (campo para resposta aberta)

OBS (Somente seguir para questão T se responder pelo menos um item)

S. Would you suggest a minimal technical protocol different from the below for acquiring **MRI** to evaluate the TMJ?

1. Closed mouth position, Spin-echo, High field
- Fast axial localizer
- Oblique sagittal, axially corrected according to the long axis of the condyle, Proton Density (PD) or T1, bilateral
- Oblique coronal, axially corrected according to the long axis of the condyle, Proton Density (PD) or T1, bilateral

2. Open mouth position, Spin-echo, High field
- Fast axial localizer
- Oblique sagittal, axially corrected according to the long axis of the condyle, Proton Density (PD) or T1, bilateral
- Oblique sagittal, axially corrected according to the long axis of the condyle,T2, bilateral

1. ( ) Yes (essa resposta leva ao aparecimento das questões de S_1)
2. ( ) No (essa resposta leva à questão T)

S_1. Type here another minimal technical protocol: ( ) - field for response

T. Have you experienced any difficulties when completing this questionnaire?

1. ( ) No (this response takes you to the screen for acknowledging your participation in this research)
2. ( ) Yes.

T_1. Which one(s)? (_______) (field for response)

ANEXOS

Anexo 1 – Parecer do Comitê de Ética

Anexo 2 – Permissão para uso de imagens de outras publicações

Anexo 3 – Normas de publicação do periódico

ANEXO 1 – Parecer CEP

PROTOCOLO N.
010/2010

UNIVERSIDADE FEDERAL DE GOIÁS
PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO
COMITÊ DE ÉTICA EM PESQUISA

PARECER CONSUBSTANCIADO

I – Identificação:

– **Título do projeto**: Critérios de diagnóstico para pesquisa das desordens temporomandibulares (RDC/TMD); suficiência, efetividade e aceitabilidade para a interpretação de imagens.

– **Pesquisador Responsável**: Luciana Pimenta e Silva Machado

VI – Parecer do CEP:

– Após análise dos documentos anexados, pelos pesquisadores, em atenção aos itens pendentes, constata-se o atendimento aos requisitos solicitados e por sua vez à resolução CNS 196/96, portanto o parecer, S.M.J deste comitê, é pela **APROVAÇÃO.**

P.S. Observações: Favor verificar as datas para entrega dos relatórios parcial e final.

VII – Data da reunião: 22 /03/2010

Assinatura do(a) relator(a):

Assinatura do(a) Coordenador(a)/ CEP: Prof. Maurício Martines Sales
Coordenador do Comitê de Ética em Pesquisa
Pró-Reitoria de Pesquisa e Pós-Graduação/UFG

ANEXO 2 – Licença para uso de imagem

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ANEXO 3 - Normas de publicação do periódico

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The Official Publication for the American College of Oral and Maxillofacial Surgery, American Academy of Oral and Maxillofacial Radiology, American Academy of Oral Medicine, American Academy of Oral and Maxillofacial Pathology, and the Organization of Teachers of Oral Diagnosis

Guide for Authors

The Official Publication for the American College of Oral and Maxillofacial Surgery, American Academy of Oral and Maxillofacial Radiology, American Academy of Oral Medicine, American Academy of Oral and Maxillofacial Pathology, and the Organization of Teachers of Oral Diagnosis

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