



UNIVERSIDADE FEDERAL DE PERNAMBUCO
CENTRO DE CIÊNCIAS DA SAÚDE
PROGRAMA DE PÓS-GRADUAÇÃO EM FISIOTERAPIA
MESTRADO EM FISIOTERAPIA

**EFICÁCIA DA TÉCNICA MANUAL DE LIBERAÇÃO DIAFRAGMÁTICA NA
DISTRIBUIÇÃO REGIONAL DE VOLUME DA CAIXA TORÁCICA,
MOBILIDADE DO DIAFRAGMA E FUNÇÃO PULMONAR DE IDOSOS
SAUDÁVEIS E COM DPOC: UM ENSAIO CLÍNICO.**

Taciano Dias de Souza Rocha

Recife, 2013



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***“A única bagagem que ninguém
poderá roubar de nós é a nossa
bagagem intelectual” (Eraldo Acioli
da Rocha)***

RESUMO

O objetivo do estudo foi analisar os efeitos da técnica de Liberação Diafragmática na função pulmonar, capacidade funcional, distribuição compartimental do volume na caixa torácica e mobilidade diafragmática em idosos e pacientes com DPOC (dois ensaios clínicos controlados e randomizados). O primeiro envolveu 18 idosos saudáveis separados entre dois grupos de 9 indivíduos (intervenção e controle). O segundo estudo contou com 19 pacientes com DPOC randomizados em dois grupos (intervenção, n=10; controle, n=9) durante seis sessões de atendimento. Observou-se que em idosos saudáveis a técnica utilizada promoveu melhora na mobilidade do gradil costal superior, além de aumento do percentual do pico de fluxo expiratório predito (PFE%), da Capacidade Inspiratória (CI) e do Volume Corrente (VC). Em pacientes com DPOC, por sua vez, não foi observada alteração no volume corrente, nem na distribuição compartimental do mesmo. Houve aumentos das pressões inspiratórias e expiratórias como efeito imediato da intervenção, enquanto a avaliação pós-tratamento apresentou melhora na mobilidade diafragmática, aumento da expansibilidade torácica (CV e CI), da pressão inspiratória nasal e da distância percorrida no teste de caminhada. Diante disso, conclui-se que os efeitos observados com a utilização da técnica de liberação diafragmática nessas duas populações sugerem a utilização desta técnica com parte de protocolos de tratamento e programas de reabilitação pulmonar para pacientes com DPOC e sujeitos idosos.

Palavras chave: DPOC. Mobilidade diafragmática. Idosos. Terapia manual. Liberação diafragmática.

ABSTRACT

The objective of this study was to analyze the effects of Manual Diaphragm Release technique on lung function, compartmental chest wall volume, diaphragmatic, pulmonary function and functional capacity of the elderly and patients with COPD. To assess this, two randomized controlled trials were done. The first enrolled 18 healthy elderly randomly assigned into two groups of 9 subjects each (intervention and control). The acute effects of the technique on pulmonary function, respiratory muscle strength and compartmental chest wall volume were evaluated. The second study enrolled 19 COPD patients randomly assigned into two groups (intervention, n = 10, control n = 9) all patients received six sessions of care. We evaluated the acute and chronic effects over diaphragmatic excursion and distance walked during the 6MWT and over the same variables of the first study. As results, the technique promoted in healthy elderly improvement in the mobility of upper rib cage, and increased the peak expiratory flow (percentage of predicted - PEF %), inspiratory capacity (IC) and tidal volume (VC). In COPD patients, in turn, there was no change on tidal volume or compartmental chest wall volume. The inspiratory and expiratory pressures were increased as acute effect of the intervention. Meanwhile the evaluation the chronic effects showed improvement in diaphragmatic mobility, increased chest expansion (CV and CI) and nasal inspiratory pressure. Thereby, the effects observed stimulate the association between the manual Diaphragm Release technique and treatment protocols to elderly and COPD patients.

Key words: COPD. Diaphragmatic mobility. Elderly. Manual therapy. Diaphragm Release technique.

LISTA DE SIGLAS E ABREVIATURAS

ATS	American Thoracic Society
CVF	Capacidade Vital Forçada
DPOC	Doença Pulmonar Obstrutiva Crônica
ERS	European Respiratory Society
IMC	Índice de Massa Corpórea
PE _{máx}	Pressão Expiratória Máxima
PI _{máx}	Pressão Inspiratória Máxima
T _{exp}	Tempo Expiratório
T _i	Tempo Inspiratório
T _{tot}	Tempo Respiratório Total
VEF ₁	Volume Expiratório Forçado no Primeiro Segundo
V _t	Volume Corrente total
V _{t ab}	Volume Corrente no Abdômen
V _{t rc, a}	Volume Corrente no Gradil Costal Abdominal
V _{t rc,p}	Volume Corrente no Gradil Costal Pulmonar
SNIP	Pressão Inspiratória Nasal de <i>sniff</i>
MHz	Megahertz

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1. INTRODUÇÃO

A DPOC é uma patologia respiratória causada principalmente pelo fumo e caracteriza-se por obstrução progressiva das vias aéreas (parcialmente reversível), hiperinsuflação pulmonar, manifestações sistêmicas e exacerbações com frequência e severidade crescentes (O'DONNELL et al., 2008). O tratamento da DPOC é focado no alívio imediato e redução do impacto dos sintomas, além da redução do risco de futuros eventos adversos à saúde, como as exacerbações (GOLD, 2011).

Nessa patologia, devido à hiperinsuflação, a cúpula diafragmática sofre achatamento e suas fibras musculares têm seu posicionamento alterado na zona de aposição diafragmática, logo, a contração muscular torna-se menos eficaz na elevação e ampliação do gradil costal inferior (CASSART et al., 1997). O diafragma então passa por redução numérica de sarcômeros a fim de restabelecer, a capacidade de gerar pressões satisfatórias para abertura das vias aéreas, entretanto como consequência sofre redução da sua mobilidade (YAMAGUTI et al., 2009). Segundo Yamagutti (2009) a redução da mobilidade diafragmática apresenta-se como principal fator de risco para o aumento da mortalidade em indivíduos portadores de DPOC.

Sabendo-se que os idosos são os mais acometidos por esta patologia, alterações mecânicas e fisiológicas inerentes a esta faixa etária são determinantes para o agravamento dos sintomas nos pacientes com DPOC (ITO E BARNES, 2009; REUTER, 2012). Dentro das alterações fisiológicas observa-se o pulmão senil, no qual há redução da área de superfície de troca gasosa e do tecido de sustentação das pequenas vias aéreas (SHARMA E GOODWIN, 2006). As complacências do pulmão e do gradil costal tornam-se alteradas e os volumes respiratórios e capacidades pulmonares são afetados. Em adição, alterações mecânicas osteomioarticulares das cartilagens costais e articulações costovertebrais aumentam a rigidez torácica, prejudicando a postura e o trabalho respiratório do idoso (HOCHHEGGER et al., 2012)

Dada a relação interdependente entre o sistema respiratório e os componentes musculoesqueléticos, diversas técnicas de terapia manual têm

sido propostas como auxiliares no tratamento dos sintomas de patologias respiratórias e compartilham o objetivo de aumentar a mobilidade das estruturas torácicas envolvidas na mecânica respiratória do paciente (CHAITOW et al., 2002; DIGIOVANNA et al., 2005). Uma das técnicas propostas pelos autores é a Liberação Diafragmática que, segundo os quais, promoveria relaxamento das fibras do músculo diafragma, ganho em amplitude de movimento do gradil costal e do diafragma. Considerando as alterações características na mecânica respiratória, dos idosos e dos pacientes com DPOC, nosso estudo objetivou a avaliação dos efeitos da aplicação desta técnica em ambas as populações.

A hipótese deste estudo é que a aplicação da técnica de liberação diafragmática seja capaz de melhorar a expansibilidade torácica, a mobilidade diafragmática e consequentemente beneficiar a capacidade de geração de gradientes pressóricos e capacidades pulmonares em idosos e em pacientes com DPOC.

2. OBJETIVO GERAL

O objetivo principal deste estudo foi avaliar o efeito da aplicação da técnica manual de Liberação Diafragmática em indivíduos Idosos e em pacientes com DPOC, na função pulmonar, distribuição de volumes pulmonares na caixa torácica, força muscular respiratória, capacidade funcional e mobilidade diafragmática.

3. OBJETIVOS ESPECÍFICOS

O objetivo geral foi subdividido em objetivos específicos e analisado sob a forma de três artigos individuais.

3.1.OBJETIVOS DO ARTIGO 1

Avaliar o efeito imediato, após a aplicação da Técnica Manual de Liberação Diafragmática, em sujeitos idosos sem história de doença respiratória, sobre a Função Pulmonar, a Força Muscular Respiratória e a Distribuição Tricompartimental dos Volumes Respiratórios.

3.2.OBJETIVOS DO ARTIGO 2

Avaliar os efeitos, imediato (após uma sessão de atendimento) e pós-tratamento (após seis sessões de atendimento), da técnica Manual de Liberação Diafragmática em pacientes com DPOC, na Função Pulmonar, Força Muscular Respiratória, Distribuição Tricompartimental dos Volumes Respiratórios, Mobilidade Diafragmática e capacidade funcional.

3.3.OBJETIVOS DO ARTIGO 3

Revisão sistemática para avaliação do efeito do treinamento muscular inspiratório no trofismo do músculo Diafragma, através do melhor nível de evidência disponível.

4. REVISÃO DA LITERATURA

O conceito mais comum de idosos baseia-se no limite etário. A Organização Mundial de Saúde (OMS) considera como idosas as pessoas acima de 65 se residirem em países desenvolvidos, enquanto em populações de países em desenvolvimento, são denominadas idosas pessoas a partir de 60 anos de idade. No Brasil, em 2011, mais de 20 milhões de pessoas apresentavam idade acima de 60 anos e representavam 10,8% da população. Estima-se que em 2020 esse percentual alcançará 13%. (WHO, 2012; IBGE, 2012)

4.1. SENESCÊNCIA E FISILOGIA RESPIRATÓRIA

O processo de envelhecimento é dinâmico, progressivo e caracteriza-se por alterações fisiológicas que comprometem órgãos e sistemas, levando ao declínio de suas funções. O sistema respiratório, por sua vez, sofre modificações morfológicas e bioquímicas que têm efeito deletério sobre a geração dos gradientes pressóricos, além dos volumes e capacidades pulmonares (PRIDE, 2005; MARTI et al., 2007).

No pulmão senil ocorre redução nas estruturas do tecido de sustentação das pequenas vias aéreas, com dilatação dos alvéolos, aumento do espaço morto alveolar e redução da área de superfície de troca gasosa (SHARMA E GOODWIN, 2006). Esta última alteração provoca uma redução da tensão alveolar, com efeitos negativos sobre a troca gasosa e o fluxo expiratório forçado. Essencialmente todos os valores de fluxos expiratórios decaem na senescência, e nos homens isso pode ser ainda mais evidente. (JANSSENS et al., 1999)

Com a progressão da idade, as complacências do pulmão e do gradil costal tornam-se alteradas. Há queda no número de fibras elásticas pulmonares e consequente diminuição do recuo elástico, além de aumento da resistência ao fluxo aéreo, o que leva ao aprisionamento de ar desencadeando o aumento da complacência do parênquima pulmonar (ITO E BARNES, 2009).

As mudanças no formato do tórax senil não possuem grandes implicações funcionais, entretanto, a rigidez do gradil costal tem implicações negativas mensuráveis. Calcificações das cartilagens costais, redução dos espaços intervertebrais e degeneração das articulações costovertebrais são mudanças estruturais que ocorrem na caixa torácica, prejudicando a postura e o trabalho respiratório dos indivíduos idosos. Este enrijecimento costal restringe a ventilação pulmonar, reduzindo o volume corrente e promovendo progressivo declínio da capacidade vital (JANSSENS et al., 1999; HOCHHEGGER et al., 2012).

Além das alterações de parênquima e gradil costal, a força dos músculos respiratórios nos idosos sofre redução, prejudicando o mecanismo de tosse, o que leva à deficiência no depuramento de secreções das vias aéreas e redução da ventilação (SHARMA E GOODWIN, 2006). Além disso, a fraqueza muscular respiratória também está relacionada à diminuição da mobilidade dos idosos, redução da função pulmonar e aumento da mortalidade. (BUCHMAN et al., 2008)

As alterações fisiológicas no sistema respiratório, inerentes ao processo de envelhecimento, levam ao efeito chamado de “enfisema senil”. Desta forma, a cascata de alterações se assemelha aos indivíduos enfisematosos onde a dilatação dos alvéolos, o alargamento dos espaços aéreos e a queda do recolhimento elástico, proporcionam aumento do volume residual, hiperinsuflação e aumento do trabalho respiratório (JANSSENS et al., 1999). Ainda não está claro como o processo de envelhecimento se relaciona com o declínio da função pulmonar dos pacientes com DPOC, porém, existem muitas semelhanças entre o pulmão senil e o pulmão dos pacientes com DPOC, onde ambos são processos complexos, resultantes de fatores intrínsecos e ambientais.

4.2. DOENÇA PULMONAR OBSTRUTIVA CRÔNICA

A Doença Pulmonar Obstrutiva Crônica (DPOC) é caracterizada pela inflamação crônica das vias aéreas, do parênquima pulmonar e sua vascularização. O processo inflamatório na DPOC difere da asma, pois nele,

não há reversão do quadro obstrutivo após o uso de broncodilatadores. (GOLD, 2011). A limitação do fluxo expiratório é a característica mais marcante dessa patologia, pois, juntamente ao colapso dinâmico nas pequenas vias aéreas, compromete a capacidade de realizar a completa expiração, provocando o aprisionamento aéreo e a hipersinsuflação pulmonar, o que contribui diretamente para a ocorrência de dispneia durante o exercício (ALIVERTI, 2008). A DPOC também está associada a múltiplas comorbidades como cardiopatia isquêmica, osteopenia, glaucoma, desnutrição, anemia, disfunções musculares periféricas, câncer e síndromes metabólicas. A incidência de eventos como ansiedade e depressão nos pacientes com DPOC varia de 20% a 50%, aumentando de acordo com a severidade da doença. (O'DONNELL et al., 2008)

4.2.1. EPIDEMIOLOGIA

A DPOC é uma das principais causas de morbidade e mortalidade no mundo. No ano de 2008, essa patologia foi responsável pela morte de 3.278.168 de pessoas em todo o mundo, dos quais 56,11% eram homens (WHO, 2008). A prevalência da doença varia de acordo com o grau de exposição ao fumo, à poluição e aos gases tóxicos, de cada região (país). Visto que a industrialização e o desmatamento são crescentes em todo o mundo, projeta-se que a prevalência da DPOC aumentará nas próximas décadas.

4.2.2. IMPACTO ECONÔMICO E SOCIAL

Os custos relativos ao tratamento dos indivíduos com DPOC têm alto impacto sobre os sistemas de saúde. O ponto mais importante, além dos medicamentos, se dá pela necessidade frequente de internamento nas exacerbações da doença (GOLD, 2011). Desordens psicológicas como a depressão, são comuns em indivíduos com essa patologia, afetando o convívio social, o trabalho e sua interação com amigos e família (JULIAN et al., 2010).

4.2.3. ALTERAÇÕES DIAFRAGMÁTICAS NA DPOC

Devido à hiperinsuflação, as fibras musculares do diafragma têm o seu posicionamento alterado na zona de aposição diafragmática, entre o músculo e

o gradil costal, tornando-se orientadas transversalmente, ao invés de verticalmente. Logo, a contração muscular torna-se menos eficaz na elevação e ampliação do gradil costal inferior, muitas vezes promovendo um efeito de redução do seu diâmetro transverso durante a inspiração, denominado de Sinal de Hoover (YAMAGUTI et al., 2008; ALIVERTI et al., 2009)

Diante da cronicidade dessa patologia, o diafragma sofre alterações com o objetivo de manter a capacidade de geração de força. O processo dá-se pela redução numérica de sarcômeros em série de suas fibras, encurtando-as, com a finalidade de aproximar-se mais do comprimento ideal original. Esta adaptação restabelece, parcialmente, a capacidade de gerar pressão satisfatória para abertura das vias aéreas, entretanto traz como consequência o rebaixamento da cúpula diafragmática e a redução da sua mobilidade (CASSART et al., 1997; KANG et al., 2011) Figura 1.

Segundo Yamaguti (2009) a redução da mobilidade diafragmática apresenta-se como um dos principais fatores de risco para o aumento da mortalidade em pacientes portadores de DPOC. Diante disso, sugere-se que além das modalidades terapêuticas utilizadas no tratamento desta patologia, como o uso de fármacos e a reabilitação pulmonar (GOLD, 2011), deve-se estimular a utilização de técnicas específicas que visem aumentar a mobilidade do diafragma e do gradil costal. (YAMAGUTI et al., 2009)

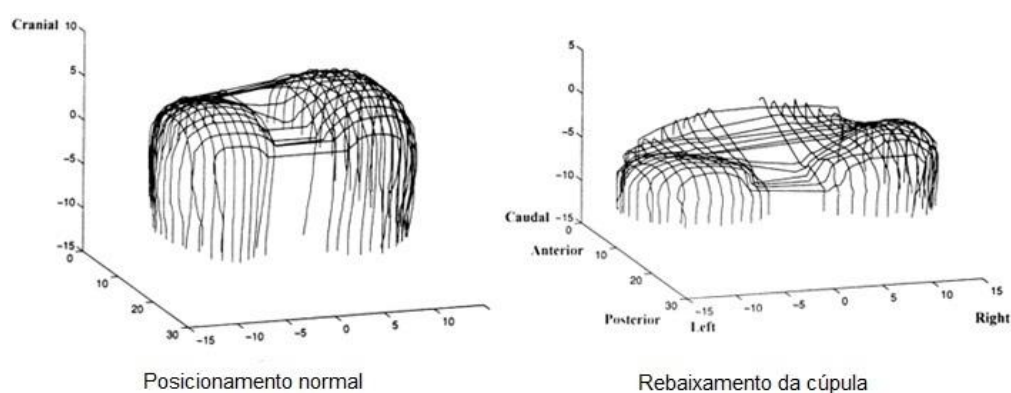


Figura 1 Rebaixamento da cúpula Diafragmática na DPOC. Adaptado de CASSART et al., (1997)

4.3. TERAPIA MANUAL NO SISTEMA RESPIRATÓRIO

A aplicação da terapia manual no tratamento de alterações do sistema respiratório tem sido proposta durante muitos anos, mas apesar das justificativas fisiológicas para o seu uso, ainda existem poucos estudos que justifiquem a real aplicabilidade clínica (ENGEL E VEMULPAD, 2011). Uma revisão sistemática recente expõe a carência de estudos com boa qualidade metodológica nessa área. (HENEGHAN et al., 2012). A revisão realizada por esses autores, sobre o uso da terapia manual na DPOC, considerou apenas dois estudos como sendo de boa qualidade metodológica, e estes apresentaram desfechos distintos (PUTT et al., 2008; NOLL et al., 2009).

O primeiro desses estudos foi o de Noll e cols. (2009), que avaliou o efeito de 4 técnicas manuais separadamente, em 25 pacientes com DPOC e observou efeitos adversos sobre a função pulmonar, principalmente nas manobras de reexpansão, apesar de 50-79% dos pacientes referirem sentir melhora na respiração após cada tratamento. O segundo estudo, foi o de Putt e cols. (2008), que por sua vez utilizaram o alongamento do músculo peitoral maior no modelo contração/relaxamento em 14 pacientes. Os pesquisadores mostraram que a intervenção foi capaz de aumentar em 9,6% a capacidade vital dos pacientes tratados.

Mais recentemente, Zanotti e cols. (2012) associaram a terapia manual a um programa de reabilitação pulmonar (PRP) de 20 pacientes com DPOC. O grupo PRP associada à terapia manual apresentou redução significativa do volume residual e incremento da capacidade funcional (TC6min) em comparação ao grupo PRP associado ao *Sham*. Porém, esses autores não definiram as técnicas utilizadas, descrevendo apenas que, após avaliação de restrições sacro-ilíacas, mobilidade do tórax e palpação de determinadas estruturas, o tratamento era dirigido para as alterações encontradas. Diante dos resultados descritos na literatura, sugere-se que a utilização de técnicas manuais sobre as alterações biomecânicas decorrentes da DPOC seja capaz de promover benefícios sistêmicos nessa população.

Entre as técnicas manuais utilizadas na prática clínica, a técnica manual de Liberação Diafragmática, utilizada originalmente com fins de redução das retrações do músculo diafragma, é referida como capaz de promover benefícios sobre o sistema respiratório e sua biomecânica. O contato manual do terapeuta sob a face inferior do rebordo costal da cartilagem comum das quatro últimas costelas permite que haja tração do gradil costal inferior em sentido cranial, além de compressão manual dos tecidos profundos localizados na zona de inserção costal anterior do diafragma (CHAITOW et al., 2002; DIGIOVANNA et al., 2005). Apesar dos efeitos enumerados pelos autores, até o presente momento, não há relatos na literatura científica de ensaios clínicos que avaliem seus efeitos em nenhuma população.

5. MATERIAIS E MÉTODOS

São descritos o registro do comitê de ética em pesquisa e o delineamento de cada estudo desenvolvido.

5.1. ASPECTOS ÉTICOS

Todos os voluntários e seus responsáveis foram informados a respeito dos objetivos e procedimentos do estudo e participaram voluntariamente, conforme determina a resolução número 196/96 do Conselho Nacional da Saúde - CNS. O presente estudo foi aceito pelo Comitê de Ética em Pesquisa da Universidade Federal de Pernambuco (CEP/CCS/UFPE nº 415/10) - Anexo 1. O termo de consentimento livre e esclarecido encontra-se exposto no anexo 2.

5.2. DELINEAMENTO DOS ESTUDOS

Ambos os estudos tratam-se de ensaios clínicos randomizados, controlados e duplo-cego. No **Artigo 1**, foram recrutados 20 voluntários com idade acima de 60 anos, sem história de doença respiratória, oriundos da comunidade, não fumantes, sedentários auto-declarados e que apresentassem volume expiratório no primeiro segundo (VEF_1) e capacidade vital forçada (CVF) maiores ou iguais a 80% do predito, além do quociente entre essas variáveis (VEF_1/CVF), maior que 70% na espirometria (PEREIRA et al., 2007). Foram excluídos aqueles indivíduos que apresentaram incapacidade de compreensão dos comandos verbais na avaliação e índice de massa corpórea (IMC) acima de $30,0 \text{ kg/m}^2$. Após a randomização, cada participante foi submetido a apenas uma sessão de atendimento, composta por: avaliação de base; aplicação da técnica ou *Sham* (de acordo com o seu grupo); e reavaliação imediata. A figura 2 representa o fluxograma dos participantes desse estudo.

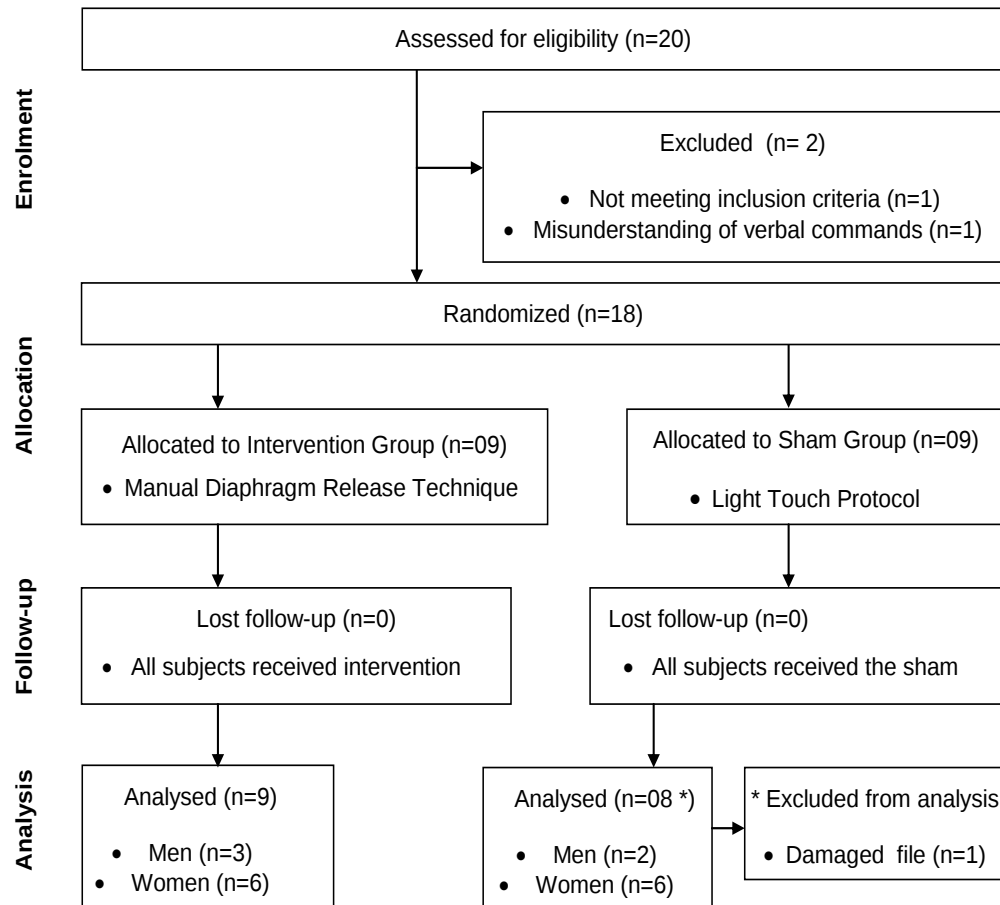


Figura 2. Fluxograma dos participantes do estudo

No **Artigo 2**, 66 pacientes com DPOC foram contatados, sendo excluídos 24 por inadequação aos critérios de inclusão e 12 por recusa da participação. Posteriormente, 30 voluntários compareceram para avaliação, sendo excluídos 8 deles por se enquadrarem nos critérios de exclusão e 2 por recusa da participação. Os 20 pacientes com DPOC restantes, alocados randomicamente entre os grupos Intervenção (n=11) e Controle (n=9). Durante o estudo, um participante do grupo intervenção desistiu do tratamento (Figura 3). Em ambos os grupos o protocolo foi composto por seis dias de aplicação da técnica, três vezes por semana, com um dia de intervalo entre eles.

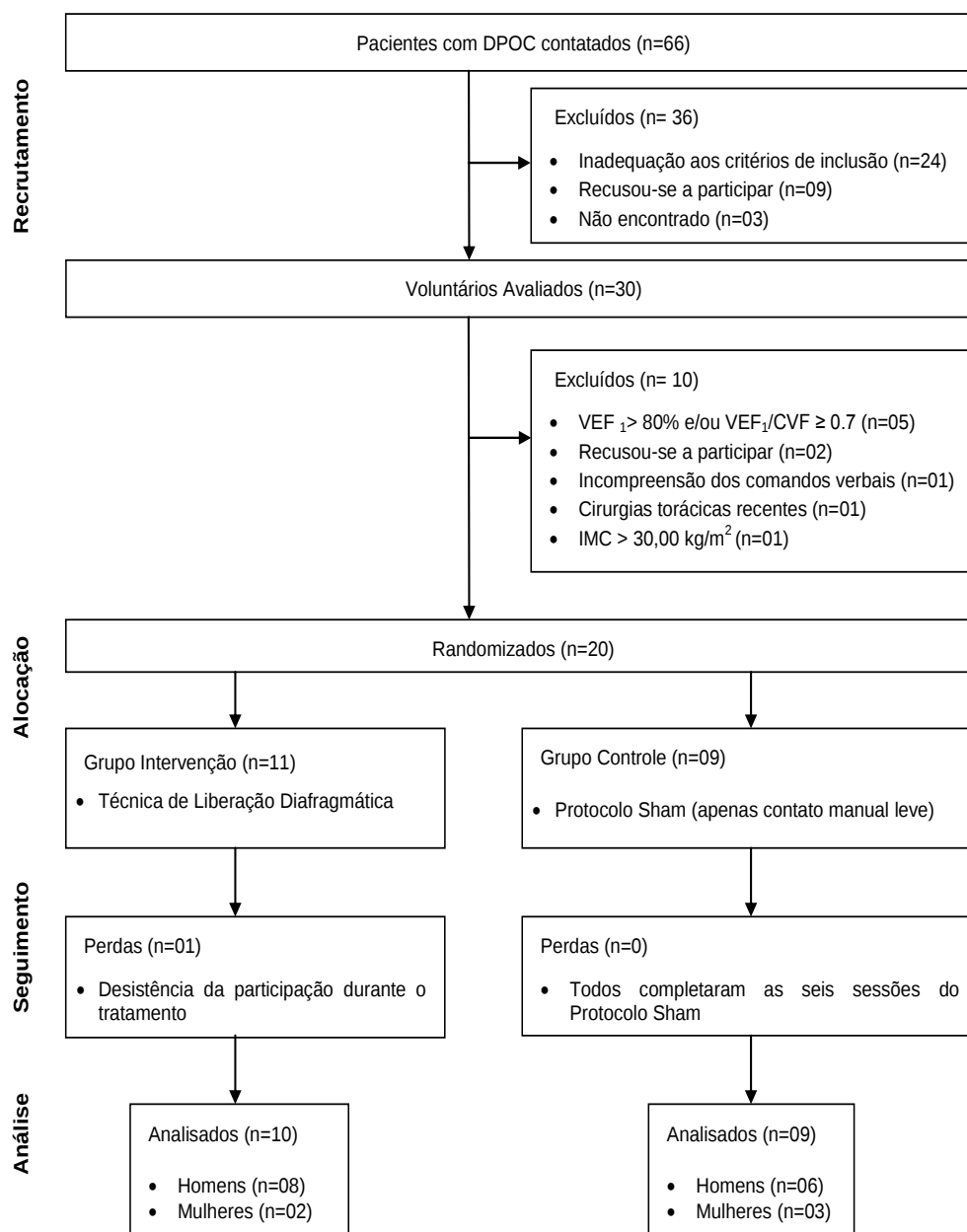


Figura 3 Fluxograma dos pacientes participantes do estudo.

Nos dois estudos acima, os voluntários do grupo intervenção (GI) foram submetidos à técnica manual de Liberação Diafragmática, enquanto os voluntários do grupo controle (GC) receberam apenas contato manual leve nos mesmos pontos anatômicos, sem tração ou pressão, com posicionamento e duração idênticos ao do GI, caracterizando um protocolo *Sham*. A figura 4 mostra os contatos, os posicionamentos e a aplicação da técnica utilizada no estudo.

6. INTERVENÇÃO

A intervenção utilizada nos ensaios clínicos (artigos 1 e 2) foi a técnica de Liberação Diafragmática.

6.1. TÉCNICA DE LIBERAÇÃO DIAFRAGMÁTICA

Para a sua realização, o paciente é posicionado em decúbito dorsal com membros relaxados. O terapeuta posiciona-se atrás da cabeça do paciente e realiza contato manual (pisiforme, bordo ulnar e três últimos dedos) com a face inferior do rebordo costal da cartilagem comum da sétima, oitava, nona e décima costelas, orientando seus antebraços em direção aos ombros do lado correspondente. Na fase inspiratória, o terapeuta traciona os pontos de contato, com ambas as mãos, em direção cefálica e levemente lateral, acompanhando o movimento de elevação das costelas. Durante a expiração, aprofunda-se o contato manual, em direção à face interna costal, mantendo a resistência exercida na fase inspiratória. Nos ciclos respiratórios seguintes, busca o ganho suave em tração e aumento no aprofundamento dos contatos.

Em cada sessão, a técnica era aplicada durante duas séries de dez ciclos respiratórios profundos, com um minuto de intervalo entre séries. O paciente era encorajado pelo terapeuta a realizar a respiração lenta, o mais profundo possível, sob o comando verbal do terapeuta: “Puxe todo o ar lentamente; Solte todo o ar lentamente”. Esse modelo foi aplicado em todos os participantes dos grupos Intervenção (artigo 1 e artigo 2).

O protocolo utilizado para os participantes dos grupos Controle (artigo 1 e artigo 2) teve características semelhantes (duração, posicionamento, número de séries, comandos verbais), entretanto nesse caso, realizou-se apenas contato manual suave nos mesmos pontos anatômicos, sem exercer tração ou pressão, caracterizando um protocolo *Sham*. O mesmo terapeuta, com experiência na técnica, foi responsável por executar os protocolos de ambos os grupos (controle e intervenção).



Figura 4 Técnica manual de Liberação Diafragmática. Paciente em decúbito dorsal com membros relaxados. Contato do terapeuta: pisiforme, bordo ulnar e três últimos dedos com a face inferior do rebordo costal da cartilagem comum da sétima, oitava, nona e décima costelas do paciente. Na fase inspiratória: tração em direção cefálica. Na fase expiratória: aprofundamento dos contatos e manutenção e resistência ao rebaixamento das costelas. Realização: 10 ciclos respiratórios; intervalo de 1 minuto; repetição de mais 10 ciclos respiratórios.

7. INSTRUMENTOS DE AVALIAÇÃO

Os instrumentos de avaliação utilizados tiveram o objetivo de analisar as características da função pulmonar, da força muscular respiratória, da capacidade funcional, da mobilidade diafragmática e distribuição regional de volumes respiratórios.

7.1. ESPIROMETRIA

A prova de função pulmonar foi realizada para os critérios de inclusão e caracterização da amostra, com o espirômetro portátil (Micro Loop 8, MicroMedical, Inglaterra). Utilizou-se a manobra de capacidade vital forçada (MILLER et al., 2005), obedecendo aos critérios de aceitabilidade de acordo com a ATS/ERS (2005)

Para execução da avaliação, o paciente era posicionado sentado em uma cadeira com apoio para os braços. O avaliador fazia uma demonstração prévia, orientando ao voluntário que realizasse uma inspiração máxima (a partir da capacidade residual funcional), seguida de uma expiração forte e explosiva (sem hesitação), prolongada até que todo o ar fosse expirado. Um bocal descartável e um clipe nasal eram utilizados no paciente e a manobra era realizada, sob o encorajamento verbal do avaliador, em no máximo oito repetições. Caso os valores de VEF1 ou CVF atingissem uma redução de 20% do valor inicial, a espirometria era interrompida (MILLER et al., 2005). Os valores preditos para a população estudada, foram considerados de acordo com Pereira e cols. (2007).

7.2. AVALIAÇÃO DA MOBILIDADE DIAFRAGMÁTICA

No presente estudo, a mobilidade diafragmática foi avaliada utilizando o ultrassom de alta resolução modelo SonoaceR3 (Samsung Medison – Coréia do Sul), munido de transdutor convexo 3,5 MHz. Antes de cada avaliação, requisitava-se ao voluntário que deitasse em decúbito declinado (45°) e respirasse calmamente durante alguns minutos, com os olhos fechados. Posicionou-se o transdutor no abdômen, na linha clavicular média direita, imediatamente abaixo da margem costal, com pressão firme, orientado em direção cranial. Para definir-se o direcionamento ideal do transdutor, utilizamos o modo-B e tomamos como referência a veia cava inferior, à direita da tela, e a vesícula biliar ao centro (TESTA et al., 2011).

Após o bom posicionamento em modo-B, mudou-se a configuração para o modo-M e sua linha de referência foi colocada no ponto distal ao transdutor, considerado representativo da maior altura da cúpula diafragmática. Em seguida, os voluntários recebiam comando verbal para realizar manobras de capacidade vital (CV), onde a medição de cada curva, referente ao deslocamento da lâmina diafragmática, era realizada imediatamente após a obtenção das imagens. A fim de reduzir a variabilidade intraobservador, eram realizadas 5 manobras, e o valor final do deslocamento foi a média dos 3 maiores deslocamentos apresentados, sem que estes diferissem em mais de 10 % do seu valor, uns dos outros. A figura 5 mostra a mensuração do

deslocamento diafragmático em uma manobra de CV realizada por um dos voluntários.

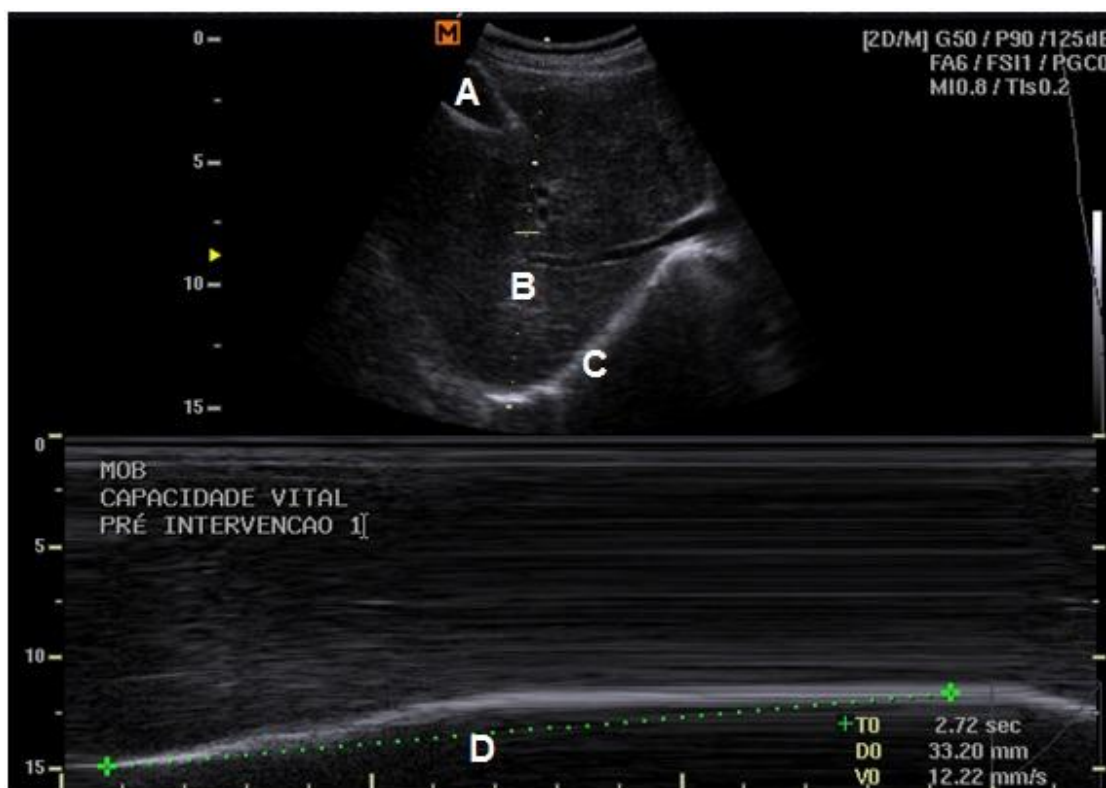


Figura 5. Avaliação da mobilidade diafragmática pela ultrassonografia em modo-M. A: Vesícula Biliar; B: Linha de referência para o modo-M; C: Diafragma; D: Posicionamento dos marcadores para medição do deslocamento do diafragma na manobra de capacidade vital. TO: Tempo decorrido durante a inspiração (em segundos); DO: Distância deslocada pelo diafragma durante a manobra (em mm); VO: Velocidade do deslocamento (em mm/s).

7.3. AVALIAÇÃO DA FORÇA MUSCULAR RESPIRATÓRIA

As Pressões Inspiratórias e Expiratórias Máximas (PI_{máx}; PE_{máx}) foram obtidas a partir do volume residual e capacidade pulmonar total, respectivamente, de acordo com os critérios da ATS/ERS (2002) e mensuradas através de um manovacuômetro digital portátil, modelo MVD 300 (MDI Ltda®, Brasil). Com o mesmo instrumento, a pressão inspiratória nasal de *sniff* do paciente (SNIP) foi avaliada pela colocação do plugue nasal em uma das narinas, sem oclusão da contralateral e realização de 10 manobras de esforço inspiratório máximo (60seg entre manobras). Foi considerado o maior valor atingido (ULDRY et al., 1997; SEVERINO et al., 2010)

7.4. PLETISMOGRAFIA OPTOELETRONICA TRICOMPARTIMENTAL

A análise da variação de volume na caixa torácica e da distribuição regional dos volumes respiratórios foi realizada com o Pletismógrafo Optoeletrônico (POE) (BTS Bioengineering- Itália), no qual 89 marcadores refletivos foram aderidos à pele do voluntário utilizando-se adesivos hipoalérgicos, em pontos anatômicos específicos da parede torácica e do abdômen (ALIVERTI E PEDOTTI, 2003). O aparelho emite luz infravermelha que é refletida pelos marcadores e captada por oito câmeras ao redor da sala, permitindo a determinação espacial de cada ponto marcado. Dessa forma, com base no teorema de Gauss, as variações de volumes pulmonares são calculadas, propiciando a divisão do conjunto tóraco-abdominal em três compartimentos, sendo: compartimento pulmonar da caixa torácica ($R_{c,p}$ – mais superior), compartimento abdominal da caixa torácica ($R_{c,a}$ – zona de aposição do diafragma) e abdômen (Ab) (CALA et al., 1996). (figura 6)

Em cada avaliação, foram registrados 3 minutos de respiração tranquila do paciente, para obtenção dos valores do volume corrente total da caixa torácica (V_t), e do volume em seus compartimentos, pulmonar e abdominal ($V_{t,rcp}$; $V_{t,rca}$), e abdômen ($V_{t,ab}$). Além disso, determinou-se o percentual de contribuição desses compartimentos sobre o volume corrente total ($V_{t,rcp}\%$; $V_{t,rca}\%$ e $V_{t,ab}\%$). Em seguida, o avaliador orientava o paciente a executar 3 manobras de capacidade vital, pelas quais eram determinados os valores da capacidade inspiratória (CI) e capacidade vital (CV). Os maiores valores atingidos de CV e CI, entre as três manobras, eram computados.

Utilizou-se uma caneta atóxica e hipoalérgica para demarcar, no voluntário, o posicionamento dos marcadores refletivos dorsais, permitindo ao paciente deitar-se em decúbito dorsal para aplicação da técnica ou *sham*, após a avaliação. Posteriormente, estes marcadores eram recolocados no local exato, para a reavaliação.

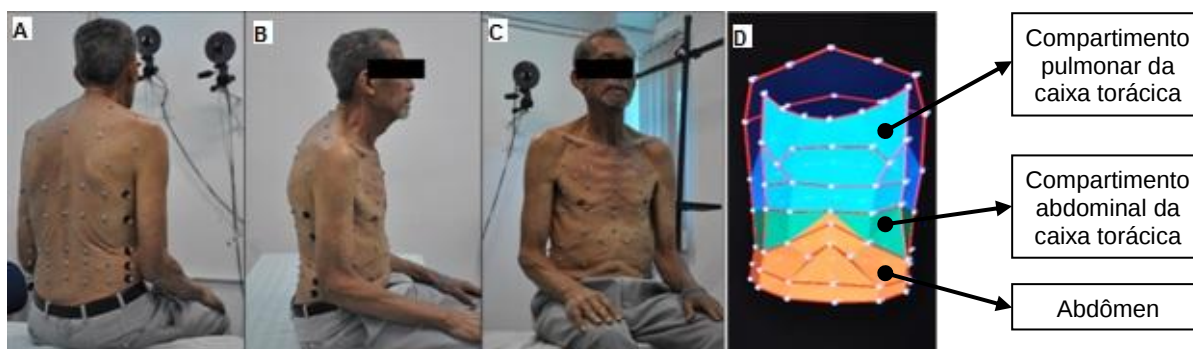


Figura 6. Pletismografia Optoeletrônica Tricompartimental. Visão posterior (A), lateral (B) e anterior (C) do posicionamento do paciente durante a avaliação e modelo em 3D (D) resultante da triangulação entre os 89 marcadores refletivos aderidos ao tórax e abdômen do paciente. Localização dos compartimentos: pulmonar da caixa torácica (Rc,p); abdominal da caixa torácica (Rc,a) e abdômen (Ab).

7.5. TESTE DE CAMINHADA DE SEIS MINUTOS (TC6 min)

O teste de caminhada de 6 minutos (TC6 min) foi realizado de acordo com as recomendações da ATS (ATS, 2002). O voluntário era orientado a comparecer com roupas leves e calçado apropriado para caminhada. Antes do início do teste eram aferidos os valores de pressão arterial, saturação do oxigênio, frequência cardíaca, ventilometria e dispneia através da escala modificada de borg, para dispneia e fadiga. A avaliação era explicada ao voluntário, para que ele percorresse em corredor de 30m de comprimento, em seu ritmo, o máximo de distância no tempo total de 6 minutos. A cada minuto do teste o avaliador utilizava frases de incentivo, pré-determinadas. Ao final do teste, o paciente era colocado sentado numa cadeira, todas as variáveis iniciais eram reavaliadas e a distância percorrida durante o teste era computada.

8. RESULTADOS

O projeto de mestrado desenvolvido resultou na elaboração de três artigos científicos. Os artigos 1 e 2 são ensaios clínicos controlados e randomizados, enquanto o artigo 3 é uma revisão sistemática.

O primeiro artigo é intitulado “A Técnica De Liberação Diafragmática Aumenta o Volume Corrente e a Contribuição Do Gradil Costal Superior Durante a Respiração Tranquila Em Idosos Saudáveis: Um Ensaio Clínico Controlado e Randomizado.” (MANUAL DIAPHRAGM RELEASE TECHNIQUE INCREASES TIDAL VOLUME AND UPPER RIB CAGE CONTRIBUTION DURING QUIET BREATHING IN HEALTHY ELDERLY: A RANDOMIZED CONTROLLED TRIAL). Participaram desse estudo, 17 voluntários com idade acima de 60 anos, separados em dois grupos, intervenção e controle. O grupo intervenção recebeu a técnica de liberação diafragmática em uma sessão de atendimento, enquanto o grupo controle recebeu apenas o toque leve, com as mesmas características do grupo intervenção.

Para avaliação desses participantes foram utilizadas Espirometria, Manovacuometria e Pletismografia eletrônica, antes e após a intervenção. Os resultados apresentados nesse estudo foram: Imediatamente após a técnica, o percentual de pico de fluxo expiratório predito aumentou em 24% no grupo intervenção ($p=0.03$). No mesmo grupo, o volume corrente total aumentou em 8,93%, com repercussões especialmente no compartimento pulmonar da caixa torácica, em um aumento de 23%. A capacidade inspiratória do grupo intervenção apresentou aumento de 7,48% após a intervenção ($p=0.04$). Diante desses resultados, pode-se concluir que no grupo estudado, a técnica de liberação diafragmática influenciou positivamente na cinemática respiratória com aumento da participação do gradil costal superior, aumento do volume corrente total, e da capacidade inspiratória.

O segundo artigo realizado é intitulado “Efeitos da Técnica Manual de Liberação Diafragmática na Mobilidade Diafragmática, Força Muscular Respiratória e Performance em Exercícios De Pacientes Com DPOC: Ensaio

Clínico Controlado e Randomizado” (DIAPHRAGM RELEASE MANUAL TECHNIQUE EFFECTS ON DIAPHRAGMATIC MOBILITY, RESPIRATORY MUSCLE STRENGTH AND EXERCISE PERFORMANCE IN COPD PATIENTS: A RANDOMIZED CONTROLLED TRIAL). Dezenove voluntários com DPOC participaram do estudo, separados em dois grupos (intervenção e controle). Foram realizadas seis sessões de atendimentos, não consecutivas, em um período de duas semanas. Foram avaliados os desfechos: mobilidade diafragmática, cinemática tóraco-abdominal, força muscular respiratória e distancia caminhada em seis minutos.

Como efeito imediato (logo após a técnica), o grupo intervenção apresentou aumento da pressão inspiratória máxima ($p=0.02$), pressão expiratória máxima ($p=0.01$) e da pressão de sniff ($p=0.001$). Ao final do tratamento (seis sessões) o efeito apresentado pelo grupo intervenção foi um aumento significativo da mobilidade diafragmática ($p=0.007$), capacidades vital e inspiratória ($p=0.04$ and $p=0.02$, respectivamente), distância percorrida em seis minutos e pressão de sniff, em comparação ao grupo controle. Deste modo, conclui-se que a técnica manual de liberação diafragmática teve efeito benéfico na função respiratória, pelo aumento da força muscular respiratória, da mobilidade diafragmática e da capacidade inspiratória, sugerindo a associação desta com cãõ desta com protocolos de tratamento em programas de reabilitação pulmonar.

O terceiro artigo realizado foi uma revisão sistemática intitulada “Efeitos do treinamento muscular inspiratório na espessura diafragmática de indivíduos saudáveis: uma metanálise” (INSPIRATORY MUSCLE TRAINING EFFECTS ON DIAPHRAGM THICKNESS IN HEALTHY INDIVIDUALS: A META-ANALYSIS). Para elaboração deste artigo foi realizada uma pesquisa por dois pesquisadores separadamente, em seis bases de dados eletrônicas, resultando em 8779 estudos inicialmente. Após a avaliação pelos critérios de exclusão resultaram 21 estudos selecionados. Destes, apenas dois foram incluídos na análise qualitativa.

A revisão sistemática realizada mostrou que não há relação de aumento da espessura diafragmática com o treinamento muscular inspiratório em indivíduos saudáveis. No entanto, esse resultado deve ser visto com cautela, pois o número de estudos existentes e, conseqüentemente, o número de voluntários avaliados ainda é reduzido. Diante disso, para o esclarecimento do efeito hipertrófico do treinamento muscular inspiratório sobre o músculo diafragma é necessário que mais ensaios clínicos sejam conduzidos com rigor metodológico apropriado e maiores quantidades de participantes.

9. CONCLUSÃO

Os resultados do presente estudo demonstram que a utilização da técnica de liberação diafragmática em idosos saudáveis pode promover de modo imediato melhoria na mecânica respiratória, com a estimulação da participação do gradil costal superior durante a respiração tranquila, aumento do volume corrente e da capacidade inspiratória. A utilização da técnica de Liberação Diafragmática em pacientes com DPOC apresentou como efeitos imediatos, ganho significativo nos valores de pressões inspiratória e expiratória máximas, além da pressão inspiratória nasal máxima. Após seis sessões de tratamento, no entanto, os efeitos observados foram o aumento da mobilidade diafragmática, do desempenho funcional (TC6min), das capacidades, vital e inspiratória e da pressão nasal inspiratória.

O conjunto dos resultados observados sugere que a utilização da técnica de liberação diafragmática foi capaz de beneficiar ambos os grupos participantes, principalmente no grupo com DPOC onde houve alívio e redução do impacto dos sintomas. A combinação desta técnica com programas de reabilitação pulmonar no tratamento de pacientes com essa doença parece então, ser potencialmente benéfica e merece ser estudada em futuras pesquisas, assim como a análise dos efeitos da técnica sobre a mecânica respiratória desse grupo, durante o exercício.

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APÊNDICE 1 - ARTIGO 1

MANUAL DIAPHRAGM RELEASE TECHNIQUE INCREASES TIDAL VOLUME AND UPPER RIB CAGE CONTRIBUTION DURING QUIET BREATHING IN ELDERLY: A RANDOMIZED CONTROLLED TRIAL

A ser submetido ao periódico:

Physical Therapy

MANUAL DIAPHRAGM RELEASE TECHNIQUE INCREASES TIDAL VOLUME AND UPPER RIB CAGE CONTRIBUTION DURING QUIET BREATHING IN ELDERLY: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Question: Does manual diaphragm release change kinematics and respiratory function of elderly subjects?

Design: Randomized controlled trial with concealed allocation and double-blinding.

Participants: 17 volunteers over 60 years old randomized into two groups: 09 in the Control Group (CG) and 08 in the Intervention Group (IG).

Intervention: The manual diaphragm release technique was used on the IG, in two sets of ten deep breaths, with a one minute interval between them. The CG underwent a sham protocol (light touch), with same sets and time of interval.

Outcome measures: The groups were evaluated using spirometry, manovacuometry and optoelectronic plethysmography (OEP), in that order, before and immediately after the intervention.

Results: Immediately after the technique, the percentage of predicted peak expiratory flow increased 24% in the IG ($p=0.03$). In the same group, the total tidalvolume (V_t) rose by 8.93% ($p < 0.05$), with repercussions especially on the rib cage pulmonary compartment by a 23% increase ($p < 0.05$). Inspiratory capacity of volunteers in the IG increased 7.48% after intervention ($p=0.04$). A significant decrease in respiratory rate (18.6 ± 4.4 vs. 13.2 ± 4.0 , $p=0.03$) was observed in the IG after the technique, when compared to CG values. Difference between the groups was not significant for values of the maximal inspiratory and expiratory pressures.

Conclusion: The manual diaphragm release technique improve the respiratory kinematic in elderly individuals with increase of participation of the upper rib cage in quiet breathing, increasing tidal volume and inspiratory capacity and reducing respiratory rate.

INTRODUCTION

Aging leads to changes in the compliance of the lungs and rib cage. There is a decreased number of pulmonary elastic fibers and consequently, a decrease in elastic recoil. Aging also leads to increased airflow resistance, which leads to air trapping and triggers increased compliance of the lung parenchyma (Zelevnik, 2005). Calcification of costal cartilage, reduction of intervertebral space and degeneration of costovertebral articulation are structural changes that occur in the chest wall, hindering posture and respiration in elderly people. This stiffening limits pulmonary ventilation by reducing tidal volume and promoting a progressive decline of up to 65% of vital capacity after 50 years of age, and by 70 years of age, only 40% of vital capacity remains (Huang et al 2011, Macnee 2009).

These changes trigger progressive air trapping, which is presented as an important limiting factor in diaphragm mobility and shape. (De Troyer and Wilson 2009, Yamaguti et al 2008). This decreased mobility of the rib cage and diaphragmatic excursion has a negative effect on the ability to generate pulmonary pressure gradients (Decramer et al 1997). All these findings result in reduced exercise tolerance and dyspnea in the elderly. Some clinical trials have been intended to delay or reduce these effects through cardiovascular fitness (Kima et al 2009), respiratory muscle training (Huang et al 2011), antioxidant diet (Kelly et al 2003) and manual therapy (Noll et al 2008, Putt et al. 2008).

In clinical practice, applications of some manual techniques in respiratory diseases like asthma, COPD and pneumonia have already been suggested (Guiney et al. 2005; Noll et al 2008, Putt et al. 2008). Nevertheless, considering the aforesaid changes in respiratory function in the elderly, there is still a shortage of literature studies investigating the effects of manual therapy on the aging process of the respiratory system. Some of these techniques appears to have the capacity to induce direct effects on the diaphragm and, consequently in the respiratory system. One of these techniques is the diaphragm release, which lengthens the fibers allowing the rib cage to achieve greater amplitude during respiration.

Considering the clinical benefits of the manual therapy, the aim of our study was to evaluate the effect of the Manual Diaphragm Release Technique on pulmonary function and compartmental chest wall volume in healthy elderly subjects.

METHODS

Design

This study was a randomized, double-blind, controlled clinical trial, involving healthy elderly, who were recruited from the local community. After their eligibility was confirmed, participants were conducted for baseline measurements of spirometry, manovacuometry and optoelectronic plethysmography (OEP) and randomly allocated to one of two groups: Control Group (CG) or Intervention Group (IG). Then, each participant was submitted to one intervention session using the manual diaphragm release technique or sham (according to group), followed by immediate reassessment.

The randomization process was performed with SPSS software version 20.0, by a collaborator who did not participate directly in the study. The concealed allocation was done by same collaborator. The participants and the physiotherapist-evaluator were blinded to group allocation. Data analysis was performed by a researcher who remained blinded with respect to the names of volunteers in each group. This study was approved by the Ethics Committee of Institutional Research and all participants signed an informed consent form.

Participants

The healthy elderly were eligible for inclusion if they had over 60 years of age, a body mass index (BMI) below 30 kg/m², non-smokers, self-declared sedentary, presenting a forced expiratory volume in one second (FEV₁) and forced vital capacity (FVC) greater than or equal to 80% of predicted, and the ratio between these variables (FEV₁/FVC), greater than 70% in spirometry (Pereira et al 2007). We excluded those individuals that showed the inability to understand verbal commands in the evaluation.

Intervention

The manual diaphragm release technique used on the IG is shown in Figure 1. To perform the technique the volunteer was placed in supine position with limbs relaxed. Positioned behind the head of the volunteer, the therapist performed manual contact (pisiform, ulnar edge and the last three fingers) with the underside of the costal cartilage of the 7th, 8th, 9th and 10th rib, and guiding forearms toward the shoulders of the corresponding side. In the inspiratory phase, the therapist gently pulled the points of contact with both hands, in the direction of the head, yet slightly lateral, accompanying the elevation movement of the ribs. During exhalation, the therapist deepened contact toward the inner costal, maintaining resistance throughout the inspiratory phase. In the breaths following, the therapist sought to gain traction and smooth increase in the deepening of contacts. This maneuver was performed in two sets of ten deep breaths, with a one minute interval between them.

For the CG, light touch at the same anatomical points was done without exerting pressure or traction. Positioning and duration were identical to the IG to perform the sham protocol (Licciardone & Russo, 2006). An experienced therapist conducted the intervention in both groups, with the objective of maintaining uniform application of the technique (intervention group) and sham (control group).

Outcome measures

Volunteers from both groups were evaluated using spirometry, manovacuometry and optoelectronic plethysmography (OEP), in that order, before and immediately after the intervention. To assess the participant's lung function, a portable Micro Loop 8 (Micromedical, England) spirometer was used to evaluate the forced maneuver (Miller et al 2005). The study followed the criteria of acceptability in accordance with the ATS/ERS (2005). Values of FEV₁, forced vital capacity (FVC), peak expiratory flow (PEF) and FEV₁/FVC were obtained. We considered the predicted values for Brazilian population (Pereira et al 2007). The maximal inspiratory and expiratory pressures (MIP, MEP) were obtained from the residual volume and total lung capacity,

respectively, according to the criteria of the ATS/ERS (ATS/ERS, 2002) and measured using a portable digital manometer, model MVD 300 (® MDI Ltd., Brazil).

The analysis of the regional distribution of respiratory volumes was done with Optoelectronic plethysmography (BTS Bioengineering, Italy), in which 89 reflective markers were adhered to the skin of volunteers using hypoallergenic adhesives, on particular anatomical points of the chest wall and abdomen (Aliverti and Pedotti 2003). The device emitted an infrared light on the reflective markers which was captured by eight cameras around the room, allowing the spatial determination of each marker. Thus, changes in lung volumes were calculated at each of the three compartments of the rib cage: pulmonary or upper ribcage (Rc, p), abdominal or lower ribcage (Rc, a) and abdomen (Ab). After the first OEP evaluation, a nontoxic, hypoallergenic pen was used to mark the placement of the dorsal reflective markers allowing the patient to lay in supine for the manual technique or the sham. The markers were then placed at the exact same anatomical points for reevaluation.

Using the OEP values, the inspiratory capacity (IC), the tidal volume of the rib cage (V_t), and its compartments, ($V_{t,rcp}$; $V_{t,rca}$; $V_{t,ab}$), were determined. Furthermore, the percentage of contribution of each compartment on tidal volume ($V_{t,rcp\%}$, $V_{t,rca\%}$ and $V_{t,ab\%}$) was established. The inspiratory (T_{insp}) and expiratory (T_{exp}) times and respiratory rate (RR) were measured.

Data analysis

SPSS software version 20.0 was chosen for the inferential analysis and descriptive data. The Wilcoxon test was used to evaluate the effects of intra-group intervention or sham assessed on each variable, and the Mann-Whitney test was applied to compare the effects between the two groups. A significance level of $p \leq 0.05$ was considered. Sample calculation for the study was done using the mean and standard deviation of the first five participants in each group. The reference variable was V_t, rcp , using an α of 0.05, a power of 0.08, by one-tailed analysis, determined the total sample of 18 volunteers.

RESULTS

Flow of Participants

Twenty elderly volunteers were recruited, two of which were excluded. The first was excluded for presentation of a BMI greater than 30 kg/m² and the second excluded due to inability to comprehend verbal commands during evaluation. Nine individuals were randomized into each group. One of the volunteers from the IG was later excluded because of technical problems in the files. Figure 2 shows the participants flow. Table 1 shows anthropometric characteristics, respiratory function and intergroup homogeneity.

Pulmonary Function

After the technique, the percentage of predicted peak expiratory flow (PEF%) had a significant increase of 24% in the intervention group ($p < 0.05$). The other spirometric variables (FEV₁%, FVC% and FEV₁/FVC%) did not change significantly between the pre and post-intervention in both groups. (Table 2).

Respiratory Muscular Strength

MIP and MEP changes between groups were not significant after the intervention. Data are expressed on table 2.

Optoelectronic Plethysmography

Compartmental chest wall volume distribution of volunteers is expressed in Figure 3. In the IG, the total tidalvolume (Vt), rose by 8.93% ($p < 0.05$). This was especially by a 23% increase in Vt, rcp ($p < 0.05$). The percentage share of each compartment on tidal volume is shown in Table 3. A significant decrease in respiratory rate (RR) was observed in the IG after the technique, when compared to CG values. The respiratory cycle times of individuals (Ttot, Tinsp and Texp) did not change significantly in both groups.

DISCUSSION

Our results demonstrates that the use of the Manual Diaphragm Release Technique improved the mobility of the upper rib cage, and also increased the percentage of predicted peak expiratory flow (PEF%), Inspiratory Capacity (IC) and Tidal Volume in the healthy elderly. These findings show acute benefits on lung function and respiratory mechanics of this population.

The use of manual therapy in the treatment of respiratory diseases has been studied in the form of protocols consisting of multiple techniques. However, this makes it difficult to understand the actual contribution each therapy has. As an example, Noll et al (2008) applied a set of seven techniques on patients with COPD and observed a detrimental effect on pulmonary function in these individuals and attributed this to one of the techniques used. Given this, the research suggested that the following studies should preferentially be oriented to evaluation of isolated techniques. With this in mind, our methodology was pioneered by applying the manual diaphragm release technique and using Optoelectronic Plethysmography (OEP) as an assessment tool in order to describe the effects on respiratory function and mechanics of the elderly.

Results obtained through the OEP suggest improvement in respiratory kinematics of the elderly participants after the manual technique, represented by an increase of 8.93% of the tidal volume of the rib cage, shown mainly by a 23% increase in V_t , rcp. A similar effect, but under different methodology, has been found by Bockenhauer et al (2002) who studied 10 asthmatic subjects, and found a 69% increase in the mobility of the rib cage, upper and lower, after the use of a manual therapy protocol consisting of 4 direct and indirect techniques. However, the comparison becomes weakened, because they have studied a group with different characteristics (asthma patients), and also used different assessment methods.

Direct and indirect techniques of muscle and respiratory structures have been described in the literature as being able to increase the mobility of the rib cage, improve the diaphragm excursion, or even reduce the deleterious effects of some respiratory diseases (Noll, Johnson, Baer, & Snider, 2009; Putt et al., 2008) However, there are few randomized controlled trials that could support

the use of these techniques and allow adjustments for methodological research, which limits the comparison of our data with other studies (Heneghan et al 2012).

The lengthening of the diaphragm fibers after using the diaphragm release may be the cause of the IC increase in the IG by elevating diaphragm dome. Thereby in accordance to force-length relationship the diaphragm muscle becomes able to generate more power do rib cage displacement (Neder et al 2003).

A comparison of the effect of increasing mobility in the upper rib cage after using the manual technique used in this study is limited by the lack of similar studies. In animals, De Troyer (2012), by applying an external force directed cranially, in the lower rib cage of sedated pigs (9th and 10th ribs) to simulate the action of the diaphragm, observed a resulting cranial displacement in the upper ribs (5 ribs) and a fall in pleural pressure. Accordingly, (in the elderly in our study) respecting the limitations of this comparison, manual mobilization of the lower rib cage, (in our study), may also have influenced the improvement in range of motion of the upper ribs, allowing the tidal volume gain in this compartment of the elderly treated. It is possible that there is more freedom in the displacement of the diaphragm, but new studies using other evaluation methods are needed. Further studies on the use of the Diaphragm Release technique in subjects with respiratory diseases and their effects on exercise, may contribute scientifically to support the use of this technique in treatment protocols for respiratory diseases, especially considering the specificities and principally, the clinical parameters of each.

Spirometry is an evaluation method capable of presenting treatment effects in the short and long term (Calverley, 2009). In this study, the elderly treated in the IG presented, in spirometry, a 24% improvement in PEF%. In healthy individuals, the generation of PEF depends, among other things, on the force generated by expiratory muscles, particularly the abdomen, which is directly proportional to the force-length relationship imposed, and consequently the level of pulmonary inflation prior to the maneuver (Quanjer et al 1997).

Seniors with low PEF% are 40% more likely to experience difficulties in Activities of Daily Living (ADLs), use more medications and are at an increased risk of hospitalization (Roberts & Mapel, 2012). Moreover, PEF has an important role during coughing, hence improvement in the mechanism of cough, assisting bronchial hygiene in the individual (Freitas et al 2010).

Aging has been associated to a decline in the compliance of chest and lung elasticity, reduction of ventilatory efficiency and depletion of muscle performance (Janssens et al 1999). The analysis of these aspects has clinical importance in assessing the effects of therapeutic interventions. The reduction in respiratory frequency of healthy elderly in the IG observed in this study suggests a positive effect on the respiratory mechanics because it reduces the effect of early closing of the airways that is common on senile lung and allows a better diaphragmatic position for the next respiratory cycle (Britto et al 2009).

As a strong point, this study applies rigorous methodology in clinical trials of manipulative therapy stimulated by Licciardone e Russo (2006), isolating the effects of one manual technique and the use of Optoelectronic Plethysmography for precise and accurate assessment of respiratory mechanics of individuals (Aliverti & Pedotti, 2003).

One of the limitations of manual therapy studies is the difficulty in following a rigid, double-blind, methodological model. Therefore, the study was blinded by the use of the sham protocol in CG (light touch) and disinformation of the data evaluators. Besides avoiding volunteers knowing which group they were allocated to, our choice of the sham protocol sought to value the nonspecific effects of therapy, as a suggestion, deposited by the relationship between the therapist and patient, beyond the proprioceptive effects (Licciardone and Russo 2006).

The results in this study demonstrate that the application of the manual diaphragm release technique can promote an improvement on the respiratory mechanic in elderly individuals with the stimulation of participation of the upper rib cage in quiet breathing, increasing tidal volume and inspiratory capacity and reducing respiratory rate.

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TABLES AND FIGURES

Table 1- Anthropometric characteristics, respiratory function (baseline) and intergroup homogeneity.

	CG (n=8)		IG (n=9)		P-value
Gender	6 M	2 F	6 M	3 F	-
Age (years)	66.6	(4.1)	64.5	(3.7)	0.29
BMI (kg/m ²)	26.2	(3.3)	25.0	(4.1)	0.52
MIP (cmH ₂ O)	75.0	(22.5)	72.1	(18.6)	0.87
MEP (cmH ₂ O)	91.2	(35.7)	107.3	(15.0)	0.66
FEV ₁ (% predicted)	90.2	(6.3)	88.0	(6.5)	0.53
FVC (% predicted)	84.2	(12.8)	87.0	(9.8)	1.00
PEF (% predicted)	73.2	(9.5)	65.8	(10.2)	0.32

CG: Control group; IG: Intervention group; M: Male; F: Female; BMI: Body mass index; MIP: Maximal inspiratory pressure; MEP: Maximal expiratory pressure; FEV₁: Forced Expiratory Volume in the first second; FVC: Forced Vital Capacity; PEF: Peak Expiratory Flow. Values expressed as mean and standard deviation; Statistical Analysis used Mann Whitney test, considering $p < 0.05$.

Table 2 - Respiratory Pressures and Pulmonary Function Analysis of Control and Intervention Group

	CG		IG		
	Baseline	Post	Baseline	Post	<i>p inter post</i>
MIP cmH ₂ O	75.0 (22.5)	72.0 (27.1)	72.1 (18.6)	79.0 (17.7)	0.53
MEP cmH ₂ O	91.2 (35.7)	79.0 (36.1)	107.3 (15.0)	105.7 (16.2)	0.24
FEV ₁ %	90.2 (6.3)	85.8 (5.4)	88.0 (6.5)	87.3 (6.7)	0.53
FVC %	84.2(12.8)	82.6 (13.6)	87.0 (9.8)	84.8 (11.8)	0.87
PEF %	73.2 (9.5)	63.4 (17.2)	65.8 (10.2)	81.8 (7.6)	* 0.03
FEV ₁ / FVC %	107.6 (8.7)	104.2 (11.9)	104.4 (7.8)	103.3 (8.1)	1.00

CG: Control Group (sham); IG: Intervention Group (Diaphragm Release); MIP: Maximal Inspiratory Pressure; MEP: Maximal Expiratory Pressure; FEV₁: Forced Expiratory Volume in First Second; FVC: Forced Vital Capacity; PEF: Peak Expiratory Flow; %: Percentage of Predicted. Values Expressed as Mean and Standard Deviation. *: $P < 0.05$. Post Intervention Intergroup Analysis: Mann-Whitney tests.

Table 3 - Evaluation of Tricompartmental Chest Wall Volume Distribution in both groups (pre and post intervention)

	CG			GI			<i>p intergroup</i>
	Pre	Post	p	Pre	Post	p	<i>post</i>
IC	1.9 (0.5)	1.8 (0.6)	0.13	1.8 (0.4)	2.0 (0.4)	* 0.04	0.49
Vt. rcp %	35.1 (11.6)	34.3 (14.3)	0.79	31.4 (9.9)	34.4 (10.4)	* 0.05	0.99
Vt. rca %	18.1 (5.0)	17.4 (7.5)	0.57	17.5 (5.4)	16.8 (5.1)	0.61	0.80
Vt. ab %	46.7 (13.9)	48.1 (17.6)	0.70	50.9 (13.5)	48.7 (14.1)	0.14	0.94
Tot	3.7 (1.6)	3.5 (1.2)	0.46	4.8 (2.3)	5.0 (1.8)	0.57	0.07
Ti	1.5 (0.7)	1.6 (0.8)	0.10	2.2 (1.1)	2.1 (0.6)	0.93	0.12
Te	2.2 (0.9)	1.9 (0.5)	0.18	2.6 (1.2)	2.9 (1.2)	0.21	0.09
Frequency	18.8 (6.6)	18.6 (4.4)	0.92	15.0 (4.7)	13.2 (4.0)	0.06	♦ 0.03

CG: Control Group (sham); IG: Intervention Group (Manual Diaphragm Release Technique); IC: Inspiratory Capacity; Vt,rcp %: Percentage of contribution of rib cage on tidal volume; Vt, rca %: Percentage of contribution of Abdominal Rib Cage on tidal volume; Tab %: Percentage of contribution of the abdomen on tidal volume; Tot: Total Respiratory Cycle Time; Ti: Inspiratory Time; Te: Expiratory Time. * Wilcoxon Test (intragroup analysis); ♦ Mann-Whitney Test (Intergroup analysis). $p < 0,05$.



Figure 1. Manual Diaphragm Release Technique Volunteer in supine position; therapist performs manual contact (pisiform, ulnar edge and the last three fingers) with the underside of the costal cartilage of the 7th, 8th, 9th and 10th rib. Inspiratory phase: therapist gently pulled in cephalic direction accompanying the elevation movement of the ribs. During exhalation: therapist deepened contact toward the inner costal margin. Following breaths: gain traction and smooth increase in the deepening of contacts. Maneuver was performed in two sets of ten deep breaths, with a one minute interval between them.

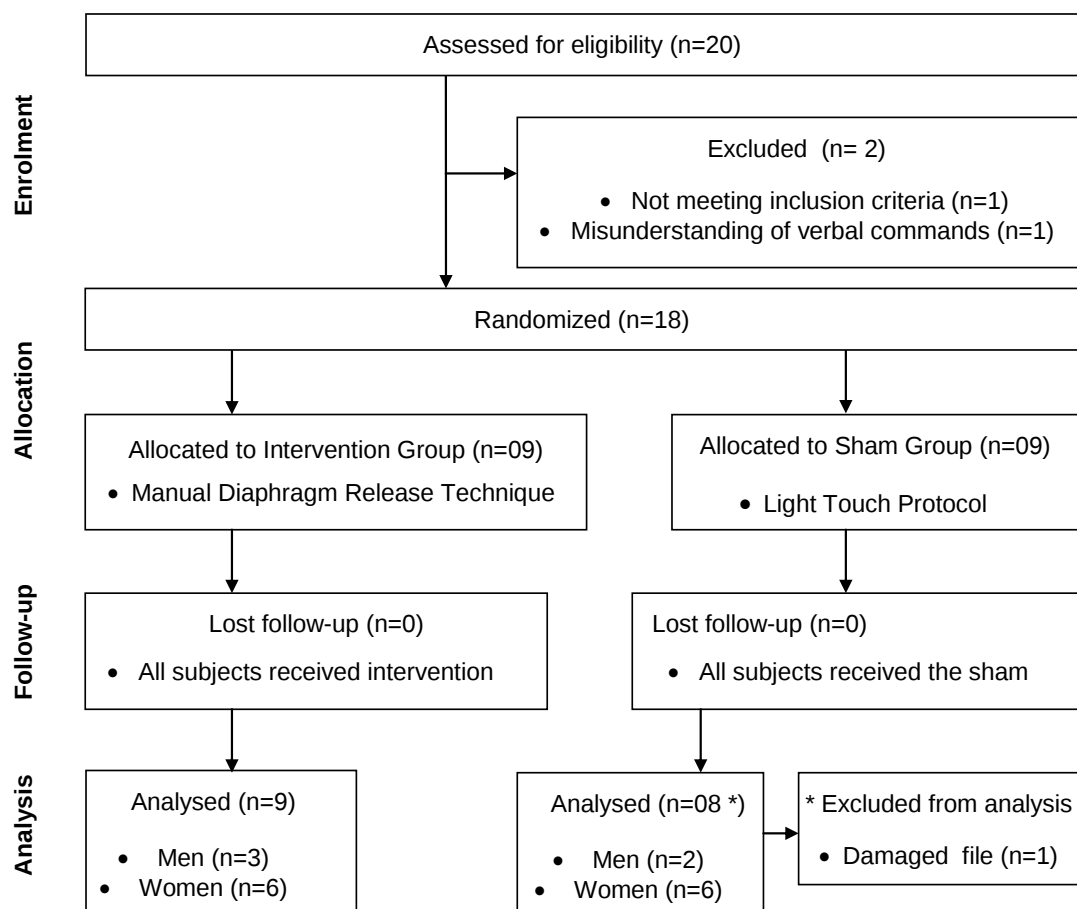


Figure 2. Participants flow.

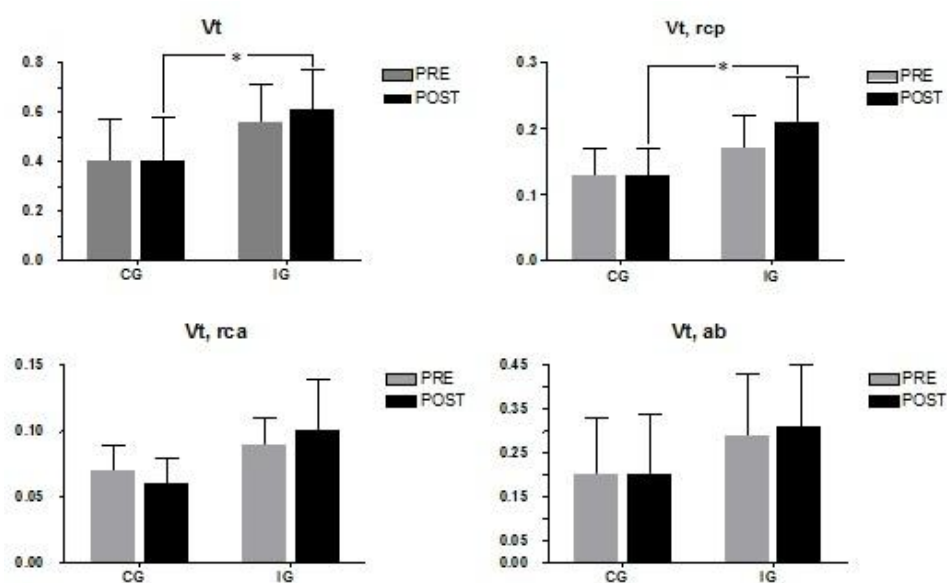


Figure 3. Tricompartmental Chest Wall Volume During Quiet Breathing. CG: Control Group; IG: Intervention Group; Vt: Tidal Volume (Total); Vt,rcp: Pulmonary Rib Cage Tidal Volume; Vt,rca: Abdominal Rib Cage Tidal Volume; Vt,ab: Abdominal Tidal Volume; Intergroups Analysis: Mann Whitney test. * $p < 0,05$

APENDICE 2 - ARTIGO 2

**DIAPHRAGM RELEASE MANUAL TECHNIQUE EFFECTS ON
DIAPHRAGMATIC MOBILITY, RESPIRATORY MUSCLE STRENGTH AND
EXERCISE PERFORMANCE IN COPD PATIENTS: A RANDOMIZED
CONTROLLED TRIAL.**

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ABSTRACT

Aims: To evaluate the effects of Diaphragm Release manual technique on diaphragm mobility, chest wall kinematics and functional capacity of COPD patients. **Methods:** Randomized controlled trial (double blinded) with 19 COPD patients, allocated in two group: intervention (IG), n=10 that received the Diaphragm Release manual technique on 6 non-consecutive sessions and control (CG), n=9 that received a sham protocol (light touch) with the same parameters of IG. The outcomes were evaluated as: immediate and post treatment effects (after 1 and 6 sessions respectively). The primary outcome was the diaphragm displacement (ultrasonography evaluation). Secondary outcomes comprised the abdominal and chest wall kinematics measured by Optoelectronic Plethysmography, respiratory muscles strength and the six minutes walking distance. **Results:** Immediate effects of the technique showed a significant increase in maximal inspiratory (MIP) ($p=0.02$), maximal expiratory pressure (MEP) ($p=0.01$) and nasal inspiratory pressure (PIN) ($p=0.001$) in IG patients. Post treatment effects observed in IG were significant increase of diaphragmatic displacement ($p=0.007$), values of vital and inspiratory capacity ($p=0.04$ and $p=0.02$, respectively), six minutes walking distance ($p=0.001$) and sniff nasal inspiratory pressure (SNIP) ($p=0.006$). There were no changes in the compartmental chest wall tidal volume between groups. **Conclusions:** Manual Diaphragm release technique improves respiratory functionality through strength and diaphragmatic mobility, inspiratory capacity and exercise performance in six minutes walking test suggesting its association with treatment protocols in pulmonary rehabilitation programs.

KEY WORDS: Diaphragm mobility, COPD, manual therapy, diaphragm ultrasonography, Optoelectronic Plethysmography.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is characterized by chronic inflammation of the airways and lung parenchyma. It's most striking feature is expiratory flow limitation. This, along with the dynamic collapse in the small airways impairs the ability to perform a complete exhalation, causing air trapping and lung hyperinflation (1).

Due to hyperinflation, diaphragm muscle fibers have their position altered in zone of opposition, becoming transversely oriented, rather than vertically. Thus, its contraction becomes less effective in raising and expanding the lower rib cage, often promoting the reduction of its transverse diameter during inspiration (2,3). The diaphragm then passes through a reduction of sarcomeres to restore the pressure generation capacity, however as a consequence diaphragm mobility is reduced. According to Yamaguti et al (2009) the reduction of diaphragmatic motion presents itself as a major risk factor for increased mortality in COPD patients (4).

The airflow limitation progresses slowly with ageing, therefore most patients who present symptoms of COPD are elderly (5). Thus, added to parenchyma abnormalities, musculoskeletal changes inherent to the ageing process are crucial to symptoms worsening in these patients (5). These include, increased chest wall stiffness due to the calcification of the costal cartilages and costovertebral joints. Those changes hinder the rib cage expansion, increase the work of breathing and reduce its functional capacity (6,7).

Given the interdependent relationship between the respiratory system and the musculoskeletal components, various manual techniques have been proposed for the treatment of COPD symptoms. They all have in common the goal of increasing the mobility of the thoracic structures involved in the respiratory mechanics (8,9). One of those techniques used in clinical practice as a mean capable of stretching the diaphragmatic fibers, and thereby increase the chest wall expansibility and diaphragm displacement, is the Diaphragm Release

Technique. Despite the description of its effects, until now there are no reports of clinical trials using this technique.

The present study aimed to assess the effects of the Diaphragm Release Technique in terms of respiratory function of COPD patients. Therefore, the hypothesis of the study is that the technique is able to improve chest wall expansion, diaphragmatic mobility and consequently benefit the ability to generate pressure gradients and lung function of COPD patients.

METHODS

The study was a double-blind randomized controlled trial with CPOD patients. Inclusion criteria considered ex-smokers, clinically stable patients (no exacerbation in the previous 6 weeks), age > 60 years, forced expiratory volume in one second (FEV1) < than 80% predicted and FEV1/FVC $\leq$ 0.7, post bronchodilator (1). Patients with other cardiopulmonary diseases, BMI > 30.0 kg/m²; with history of thoracic surgery; who denied to participate and was unable to understand verbal commands of the evaluation were excluded.

A portable spirometer Micro Loop 8 (Micromedical, England) was used to assess the forced maneuver according to ATS/ERS acceptability criteria (10). The predicted values for Brazilian population were considered according to Pereira et al (11).

A random number table was used to randomize volunteers between intervention group (IG) and control group (CG) by an assistant who did not participate directly in the research. He indicated to the therapist, in which group the volunteer would be allocated only few moments before the intervention.

For both groups, the treatment lasted two weeks and consisted of six sessions, with a 1 or 2 days interval between each session. All patients underwent four evaluations throughout treatment: before and immediately after the 1st Session (Pre 1 and Post 1) and immediately before and after the 6th session (Pre 6 and Post 6). In the other treatment sessions (2nd to 5th) patients received only the intervention according to the assigned group (Figure 1).

Patients assigned to IG received the manual diaphragm release technique, shown in Figure 2. To perform the technique the volunteer was placed in supine position with limbs relaxed. Positioned behind the head of the volunteer, the therapist performed manual contact (pisiform, ulnar edge and the last three fingers) with the underside of the costal cartilage of the 7th, 8th, 9th and 10th rib, and guiding forearms toward the shoulders of the corresponding side. In the inspiratory phase, the therapist gently pulled the points of contact with both hands, in the direction of the head, yet slightly lateral, accompanying the elevation movement of the ribs. During exhalation, the therapist deepened contact toward the inner costal, maintaining resistance. In the following respiratory cycles, the therapist progressively increased the contacts. The maneuver was performed in two sets of ten deep breaths, with a one minute interval between them.

In the CG, a sham protocol was applied. Manual contacts, duration and patient's positioning were identical to the IG, with the therapist holding only light touch in the same anatomical landmarks, without exerting pressure or traction (12). The same therapist performed the intervention in both groups, in order to keep uniform the application of the technique (GI) and sham (GC). The researchers responsible for the patients evaluations and data analysis were not allowed to know to which group each participant belonged. All patients remained blinded about their assignment during the treatment.

a) Diaphragmatic Mobility;

To evaluate diaphragmatic mobility a high-resolution ultrasound SonoaceR3 (Samsung Medison - South Korea) with a 3.5 MHz convex transducer was used according to the protocol suggested by Testa, et al (13). Volunteers received verbal command to perform Inspiratory capacity maneuvers (IC), and the measurement of each curve referring to the diaphragmatic displacement (in mm) was performed immediately after obtaining the images. The maneuvers were repeated until obtaining 5 satisfactory images. The average of the three highest values not differing by more than 10% between their values was accepted. Figure 3 shows the measurement of the diaphragm displacement on a maneuver performed by one of the volunteers.

b) Six-minute walking distance;

Six-minute walking tests (6MWT) were performed in accordance to the ATS/ERS (14) criteria, in the moments: Pre 1 and Pre 6.

c) Respiratory muscle strength;

Maximum inspiratory and expiratory pressures (MIP, MEP) were obtained from the residual volume and total lung capacity, respectively, according to ATS/ERS (10) criteria. A portable digital manometer, model MVD 300 (® MDI Ltda, Brazil) was used to perform the evaluation. With the same instrument, the patient's nasal inspiratory pressure (SNIP) was assessed by placing the nasal plug into one nostril, without contralateral occlusion. Ten Sniff maneuvers were performed with maximal inspiratory effort (60 seconds between each) and the greatest value achieved was considered (15).

d) Compartmental Chest wall volume;

Chest wall volume variations and regional distribution during Inspiratory Capacity maneuvers were measured by Opto-electronic Plethysmograph (OEP) (BTS Bioengineering, Italy). 89 reflective markers were placed on volunteer's skin surface using a hypoallergenic adhesive on specific anatomical points of the chest wall and abdomen (16). Thus, changes in chest wall volumes were calculated, allowing to acquire total chest wall volume (V_{cw}) and the division into three compartments, namely: pulmonary rib cage (R_{c,p}), abdominal rib cage (R_{c,a}) and abdomen (Ab) (17), during quiet breathing, inspiratory capacity (IC) and vital capacity (VC), maneuvers.

Patients were evaluated by OEP in seated position. After the pre treatment OEP measurements, the markers on patient's back were removed and their positions marked by a non-toxic pen, allowing the replacement of those in the exact location for the revaluation.

STATISTICAL ANALYSIS

To calculate the power of the sample G Power 3.1.3 software was used with a post-hoc test. The variable analyzed was the diaphragm mobility after treatment, whereas an increase of 45.93% for the intervention group compared

to the control group. Thus we found a power of 99% and α of 5% in a two-tailed analysis. Statistical analysis of the data was performed with SPSS software (v. 20). The analysis of intergroup data Post 1st session (immediately after 1st session) was used to evaluate the immediate effects of the intervention. In turn, intergroup data analysis Post 6th session (immediately after 6th session), aimed to assess the immediate effect with a cumulative condition. To represent an all treatment effect was used Intergroup analysis of differences between Post 6th x Pre 1st session data (6 sessions). For intergroup analysis we used Mann-Whitney U test, considering $p < 0.05$. The correlations between variables were performed using the Spearman test.

RESULTS

Figure 4 shows the flowchart of the study, while in Table 1 anthropometric characteristics, baseline data and homogeneity between groups are reported.

a) Diaphragmatic Mobility

The diaphragmatic mobility data of both groups are described in Figure 5. Post 1st session, CG showed a gain in diaphragm mobility of $-1,36 \pm 4,63$ cm, meanwhile IG gain was $2,36 \pm 5,55$ cm ($p > 0,05$). Post 6th session, comparison of gains was significant (CG $-1,09 \pm 2,61$ cm; IG $6,58 \pm 4,54$ cm; $p < 0,01$). A relevant result was shown when (Post 6th x Pre 1st) was evaluated (CG $-5,82 \pm 11,43$ cm; IG $20,32 \pm 8,20$ cm; ($p < 0,01$).

b) Six-minute walking distance (6MWD)

The IG 6MWD, after six sessions, showed a gain of 16.01 ± 14.16 m (446.60 ± 81.19 m Pre- 1 vs. 461.70 ± 82.46 m - Pre 6), while CG a variation of -6.44 ± 6.10 m (421.55 ± 63.00 m vs. 415.11 ± 61.73 m). Comparison between groups after treatment was significant ($p < 0.001$). However, when considering a cutoff distance of 25m as the minimum clinically significant distance to COPD (18), only three patients reached this value (all belonging to IG).

c) Respiratory Muscle Strength

The evaluation of the immediate effect of the technique showed greater gains of MIP, MEP and SNIP in IG compared to the CG ($p < 0.05$). When the all treatment effect was analyzed, we only observed significant gains of SNIP in IG. Table 3 shows the data and inter-group analysis.

d) Optoelectronic Plethysmography

Differences in the IC and VC between groups during treatment were observed. The intergroup analysis of Post 6 data showed that the VC of IG patients significantly increased at the end of treatment ($p = 0.01$) compared to the CG. The outcome was similar with respect to IC, which significantly increase in IG at the end of treatment ($p = 0.009$), compared to GC. Figure 6 shows the difference of these variables between groups. When evaluated during quiet breathing, none of the groups showed changes in Vt and their percentage chest wall distribution after treatment

Abdominal volume (Vab) was the mainly responsible for IC increasing in the IG as shown in figure 7. The correlation between diaphragmatic mobility gain and abdominal compartment volume, showed moderate correlation ($r^2 = 0,530$) during the treatment (figure 8).

DISCUSSION

Our results shows that the manual diaphragmatic release technique, after 6 sessions, promoted positive effect on diaphragm mobility, six-minute walking distance, Inspiratory and Vital Capacities and SNIP, in patients with COPD. As an immediate effect of the technique we observed a significant gain in values of maximum inspiratory and expiratory pressure and SNIP of treated patients. The gain of diaphragmatic motion showed moderate correlation with abdominal volume during IC maneuvers.

The methodology used in our study is pioneer by applying manual diaphragmatic release technique. Thus, comparison of our results with those reported in the literature becomes difficult. The lack of studies on manual

therapy in patients with COPD was highlighted by Heneghan et al (19) in their systematic review, also revealing that the variety of protocols used and the lack of blinding and allocation concealment were recurring in these studies, raising their risk of bias.

In the present study, IG patients showed a significant increase in diaphragmatic mobility after treatment, compared to the CG. These results suggests a benefic effect over diaphragm insercional component, favoring respiratory mechanics in the IG patients, since the technique acts on the underside of last four ribs costal cartilages allowing to traction the lower rib cage cranially, and manual compression of the deep tissues located in the area of insertion of the anterior costal diaphragm fibers.

To date, there are no studies in the literature that evaluated changes in tidal volume by studying the kinematics of thoracoabdominal complex in COPD patients after manual therapy techniques. However, Wilkens et al. (2010) observed that despite the structural remodeling experienced by the diaphragm in this pathology, its ability to generate tidal volume remains preserved (20). So, since this was an evaluation during quiet breathing, seems justified the lack of treatment effect on this variable.

Changes in MIP, MEP and SNIP detected immediately after the application of the technique appear to be related to the learning effect, since between assessment and reassessment of these variables, there was only a short time. However, SNIP effect at the end of treatment might be associated to increased diaphragm mobility shown in these patients, since SNIP relates more to the diaphragm muscle activity compared to MIP (10). Therefore, according to the length-tension law, the technique might have been able to raise diaphragm resting position and favor the pressure gradients generation (21).

The observed increase in vital capacity after the treatment was similar to the results of Putt et al. (2008). Respecting the methodological differences, but in order to observe the effects of manual therapy in this population we mentioned this study in which the authors used a hold and relax stretching technique of the pectoralis major in 14 patients with COPD during two treatment

sessions, and also observed a significant increase in vital capacity in the treated group (22). Increased VC in COPD patients is associated with a lower residual volume and a more efficient lung emptying (23).

The post treatment evaluation also showed an increase in IC presented by IG patients. This effect suggests an improvement in mobility of the rib cage and decreased hyperinflation, since the IC is considered a measure capable of estimating the reduction of air trapping. Opposed to this finding, Noll et al, (2008) observed significant increase in inspiratory capacity and total lung of patients with COPD treated with a protocol of manual therapy, but was also reported an unwanted increase in residual volume (RV) after treatment. However, these authors justify negative effect by the inclusion of an expansion technique in their protocol (24).

Given the fact that chest stiffness, results from calcification of the costovertebral joints, intervertebral discs and costal cartilages in elderly causing the decline in vital capacity of patients with COPD (6), our results in vital capacity evaluation suggest that treated patients increased chest wall expansion, represented by increases in IC and VC derived from lower rib cage cranially oriented traction in the technique. Thus during repeated respiratory cycles it may have promoted the mobilization of the joints associated to respiratory mechanics, assisting the gain in range of motion of the entire rib cage.

The combination of manual therapy with pulmonary rehabilitation programs was performed by Zanotti et al. (2012). These authors used manual therapy together with a pulmonary rehabilitation program (PRP) consisting of 20 patients with COPD. The PRP group associated with manual therapy showed significant reduction in residual volume and 72.5m increase in six-minute walking distance (6MWD). In their methodology, however, the authors did not describe the manual techniques used (25). Our results show that the use of manual diaphragm technique was able to benefit patients with COPD treated, relieving and reducing the impact of the symptoms. The combination of this technique with pulmonary rehabilitation programs in the treatment of patients

with this pathology appears to be potentially benefic and worth to be evaluated in future studies, as well as the analysis of their effect on respiratory mechanics during exercise.

In terms of limitations of the study, it could have been important to evaluate groups with different ages or levels of severity of the disease and then stratify according to their classification or age. However as the vast majority of patients affected by the disease are generally over 60 years, this study focused on a segment of the population that can be enhanced with the inclusion of manual therapy in the treatment of these patients.

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TABLES AND FIGURES

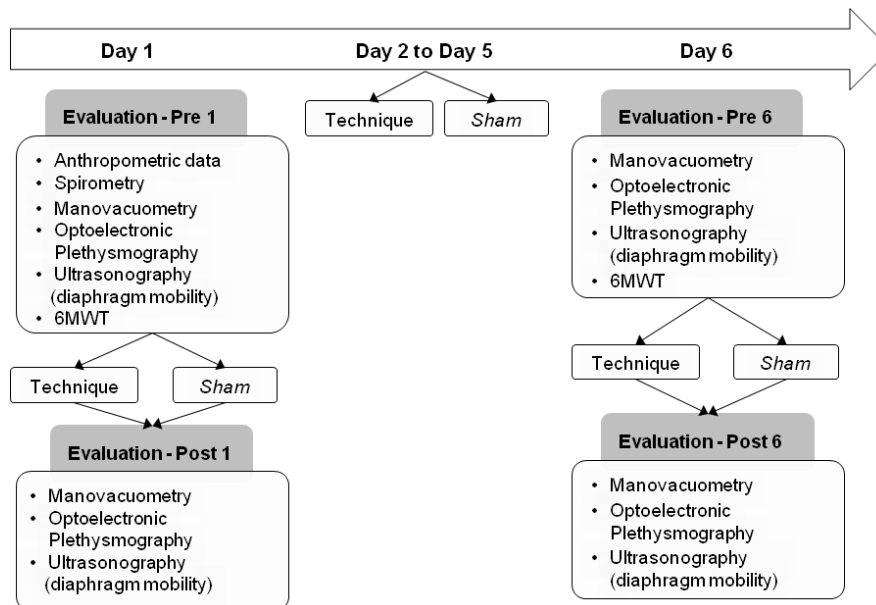


Figure 1. Treatment description.



Figure 2. Manual Diaphragm Release Technique Volunteer in supine position; therapist performs manual contact (pisiform, ulnar edge and the last three fingers) with the underside of the costal cartilage of the 7th, 8th, 9th and 10th rib. Inspiratory phase: therapist gently pulled in cephalic direction accompanying the elevation movement of the ribs. During exhalation: therapist deepened contact toward the inner costal margin. Following breaths: gain traction and smooth increase in the deepening of contacts. Maneuver was performed in two sets of ten deep breaths, with a one minute interval between them.

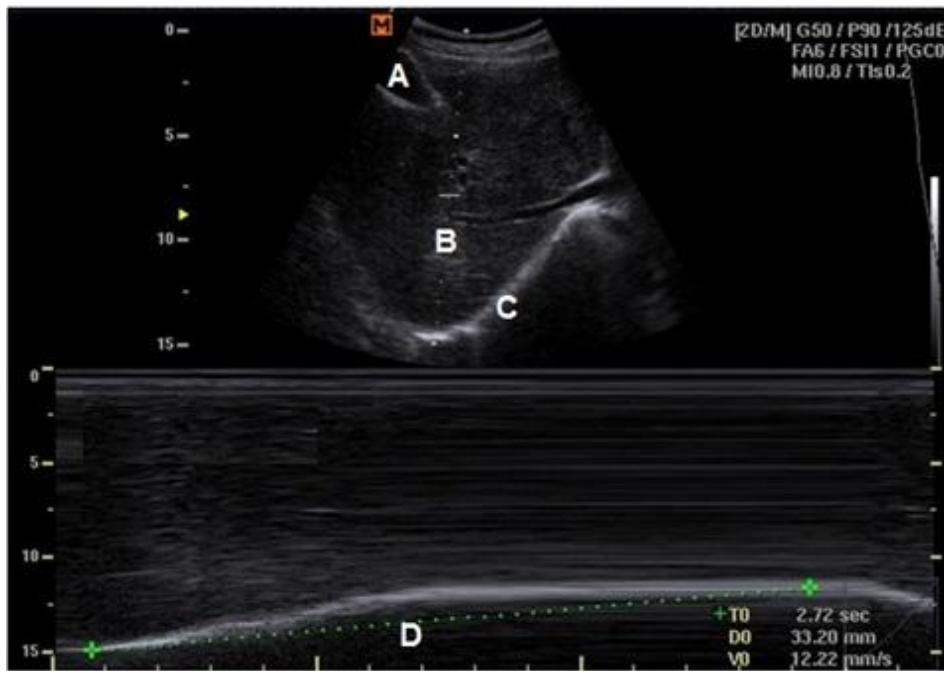


Figura 3 M-mode Diaphragm ultrasonography. A: Gallbladder; B: Reference beam for M-mode evaluation; C: Diaphragm; D: Markers positioning for diaphragm displacement measurements; TO: Inspiratory time (sec); DO: Diaphragm displacement (mm); VO: Velocity of displacement (mm/sec).

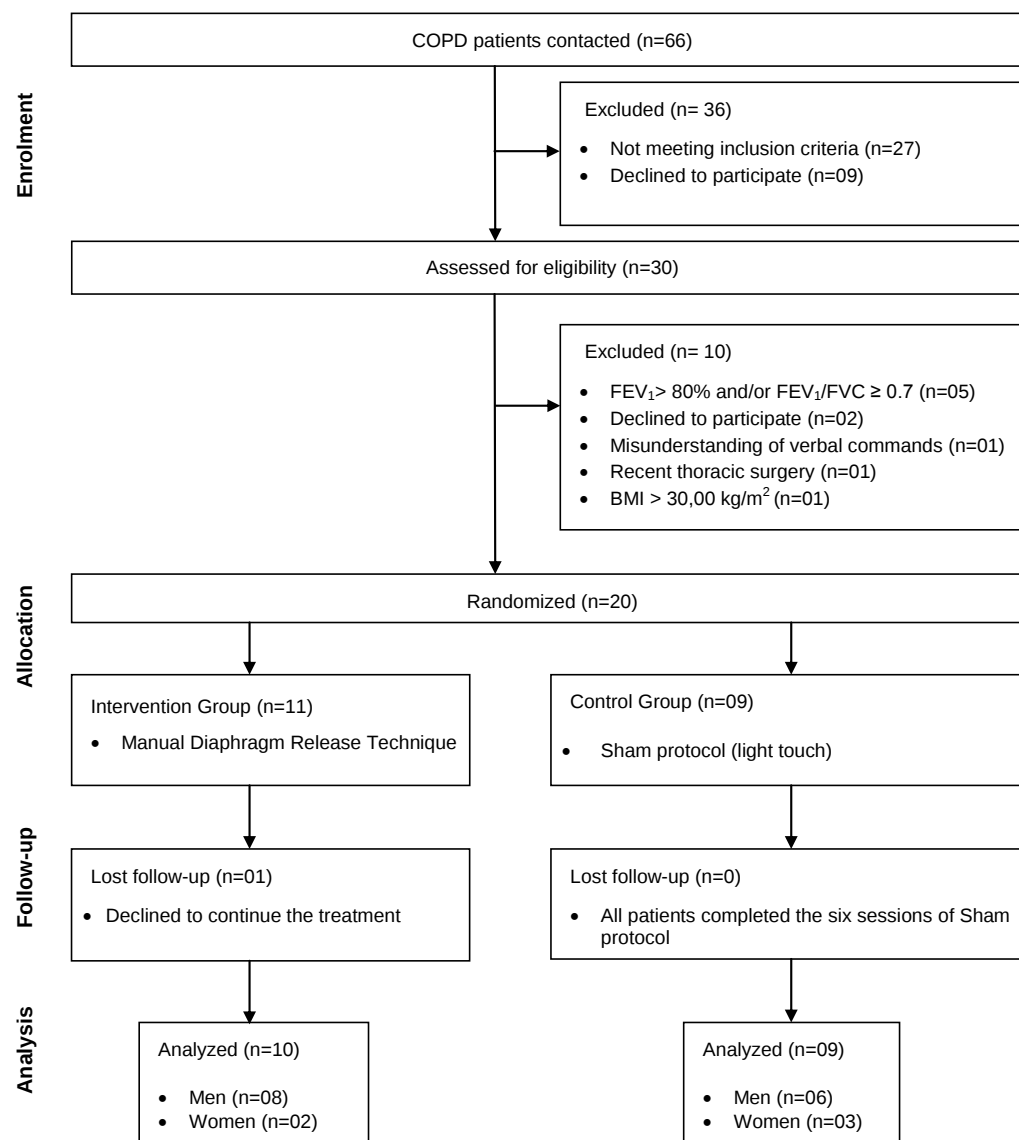
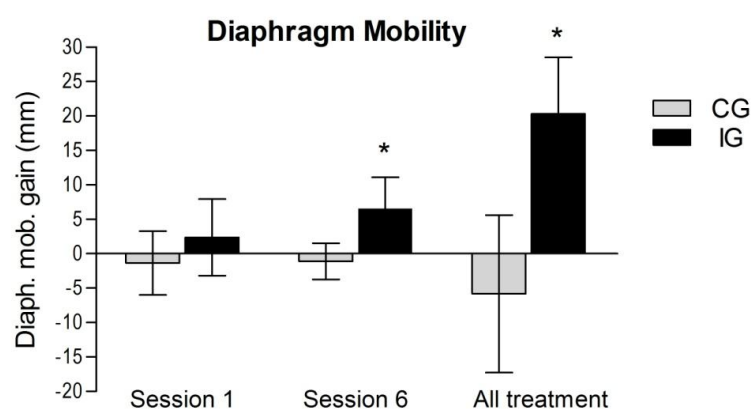


Figura 4. Patients flow.

Table 1. Anthropometric and functional characteristics of patients in both groups.

Variable	Control Group		Intervention Group		p
	Mean	SD	Mean	SD	
Gender	6 M 3 F		8 M 2 F		
Age (years)	71.0	± 6.4	70.9	± 5.3	NS
BMI (kg/m ²)	25.9	± 3.2	23.9	± 4.4	NS
FEV ₁ (%)	36.2	± 12.6	33.4	± 12.2	NS
FVC (%)	52.2	± 17.2	47.5	± 9.4	NS
FEV ₁ /FVC (%)	52.6	± 4.9	49.1	± 8.6	NS

M: Male; F: Female; BMI: Body mass index; FEV₁: Forced expiratory volume in first second; FVC: Forced vital capacity. Mann-Whitney U, $p < 0.05$.

**Figure 5.** Diaphragm mobility Gain in both groups during the treatment. Mann-Whitney test. * $p < 0.01$.**Table 2.** Immediate and post treatment effects on respiratory muscle strength in both groups.

	Session 1						Session 6							
	Pre		Post		$\Delta 1$ (%)		Pre		Post		$\Delta 2$ (%)		$\Delta 3$ (%)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
MIP														
CG	64.1	± 10.6	59.1	± 10.6	-9.1	± 8.2	60.7	± 14.0	60.6	± 13.7	-0.1	± 3.1	-8.1	± 13.2
IG	63.8	± 19.8	66.8	± 18.1	*3.1	± 21.8	64.3	± 19.8	68.7	± 24.8	*4.0	± 9.8	4.3	± 17.7
					* $p = 0.027$						* $p = 0.027$		$p = NS$	
MEP														
CG	99.3	± 21.8	88.8	± 19.2	-12.0	± 8.6	106.9	± 18.6	101.7	± 16.6	-5.0	± 6.3	2.6	± 14.5
IG	98.2	± 29.7	100.5	± 26.9	1.3	± 17.6	104.2	± 30.3	105.4	± 31.7	0.9	± 5.9	3.3	± 23.2
					$p = 0.014$						$p = 0.041$		$p = NS$	
SNIP														
CG	52.9	± 11.6	49.9	± 9.7	-5.9	± 9.3	49.1	± 7.5	48.4	± 7.8	-1.8	± 8.0	-10.2	± 21.8
IG	48.2	± 12.1	55.6	± 8.2	*14.3	± 11.1	50.7	± 11.8	58.9	± 12.7	*13.5	± 9.5	*16.9	± 21.9
					* $p = 0.001$						* $p = 0.002$		* $p = 0.006$	

Data expressed as mean and standard deviation; $\Delta 1$ and $\Delta 2$: Immediate gain; $\Delta 3$: Post treatment gain; CG: Control Group; IG: Interventions Group; MIP: Maximal inspiratory pressure; MEP: Maximal expiratory pressure; SNIP: Nasal Inspiratory pressure; Intergroup analysis. Mann Whitney test. * $p < 0.05$

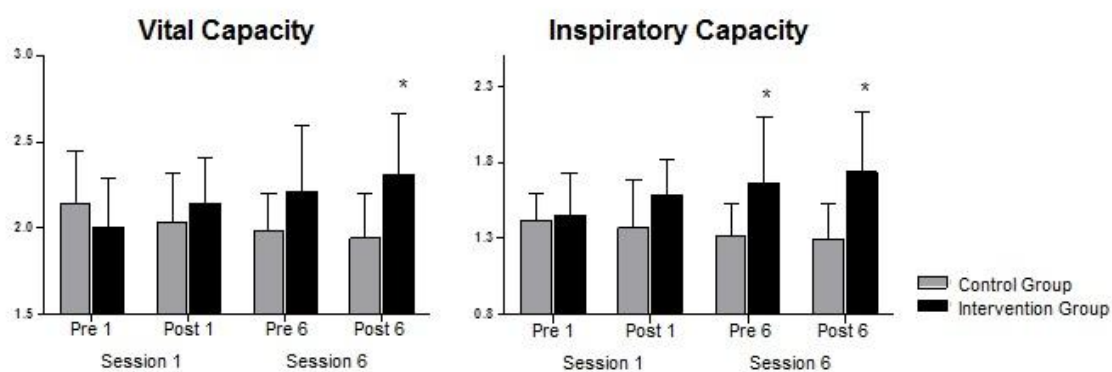


Figure 6. Vital capacity and inspiratory capacity in both groups. Mann-Whitney test. * $p < 0.05$.

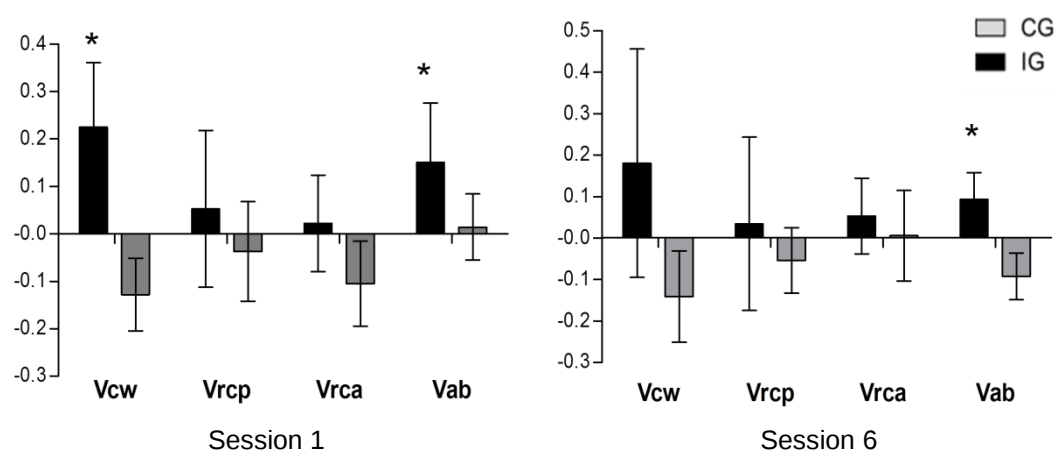


Figure 7. Gains on total chest wall volume (Vcw) and compartmental volumes (Vrcp, Vrcp, Vab) during Inspiratory Capacity maneuver in both groups. Mann-Whitney test. * $p < 0.05$.

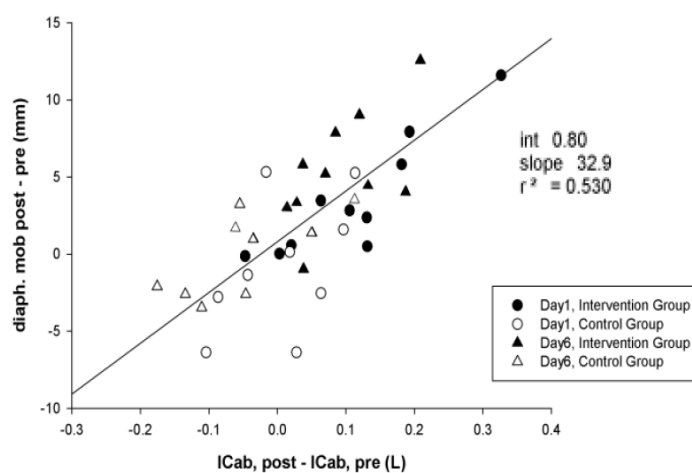


Figure 8. Correlation between Diaphragm mobility and ICab gains.

APENDICE 3 - ARTIGO 3**INSPIRATORY MUSCLE TRAINING EFFECTS ON DIAPHRAGM
THICKNESS IN HEALTHY INDIVIDUALS: A META-ANALYSIS**

A ser submetido ao periódico:

Archives of Physical Medicine and Rehabilitation

INSPIRATORY MUSCLE TRAINING EFFECTS ON DIAPHRAGM THICKNESS IN HEALTHY INDIVIDUALS: A META-ANALYSIS

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INSPIRATORY MUSCLE TRAINING EFFECTS ON DIAPHRAGM THICKNESS IN HEALTHY INDIVIDUALS: A META-ANALYSIS

INTRODUCTION

In processes such as senescence, intensive care and disuse, deleterious changes in musculoskeletal tissue can be observed, leading to a reduction in the functional capacity of individuals (Grosu et al., 2012). The respiratory muscles are also affected by this reduction on muscle strength and consequent alteration of its capacity to produce gradients pressure. Such changes trigger a decline in pulmonary function, dyspnea, and exercise intolerance. (Buchman et al., 2008), (Dall'ago, Chiappa, Guths, Stein, & Ribeiro, 2006) This panorama is also observed in some diseases such as asthma (De Bruin, Ueki, Watson, & Pride, 1997) Cystic fibrosis (Dufresne et al., 2009) and some chronic diseases such as Chronic Obstructive Pulmonary Disease. (Huang, Yang Wu & Lee, 2011), (Marquis et al. 2002)

The specific training of the respiratory muscles, especially the inspiratory muscle training (IMT) with linear load, is suggested to develop the strength of respiratory muscles and increase the resistance to fatigue, generating gains on functional capacity, decreased dyspnea and improved quality of life of patients with weakness of these muscles. (Inbar, Weiner, Azgad, Rotstein, & Weinstein, 2000), (Markov, Spengler, Knopfli-Lenzin, Stuessi, & Boutellier, 2001) However, the mechanisms responsible to these effects have not been fully elucidated yet. (Downey et al. 2007)

The force that skeletal muscle can generate depends, among other factors, to the cross-sectional area and its geometry, for which distributes its tensile strength. The increased cross-sectional area of the inspiratory muscles by hypertrophy may reverse or soften the impact of the weakening of inspiratory muscle function. (Rochester, 1988) To define the histological effects on the

diaphragm after training, it would be necessary invasive evaluation (muscle biopsy), making it challenging to measure the effects of IMT on diaphragm muscle hypertrophy. (Ayoub, et al. 1997)

The observation of the effects of IMT on the inspiratory muscles presents an important role in the evolution of pulmonary rehabilitation conduit and can be reflected by the diaphragm strength or muscle volume. This volume can be measured by mechanisms such as invasive muscle biopsy or noninvasive ultrasound exam through (Ayoub et al., 1997). The ultrasound evaluation of the diaphragm in the zone of apposition, commonly used to diagnose his paralysis, can determine the cross section of this muscle, with high accuracy and reproducibility (Dessap, Vargas, Lyazidi, Thille, & Brochard, 2012) and has been shown as a useful tool for this purpose. (Testa et al. 2011)

Despite the consensus in the literature about the increase in respiratory muscle strength by using the IMT in several populations, the effect of training on muscle thickness is still questionable, what makes relevant the focus of this work. Thus, the aim of this systematic review was to evaluate through the best evidence available the efficacy of inspiratory muscle training on the trophism of diaphragm muscle in healthy subjects.

METHODS

STUDY DESIGN

This research was conducted in the following electronic databases: Medline via PubMed, SciELO, LILACS, Cochrane and PEDro. The search strategy was done in accordance to the Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011). There was no language or year of publication restriction. The search was conducted by two independent researchers (TDSR and HCMS) in the period from 03/09/2012 to 18/12/2012, on separate computers. Crosses were made between words and after the capture of articles data were exposed to verify the occurrence of disparity and disagreement regarding the inclusion / exclusion of studies and duplications.

STUDY SELECTION CRITERIA

Randomized controlled trials in healthy adults of both sexes were defined as inclusion criteria. We considered as the primary outcome diaphragmatic thickness assessed by ultrasonography. Isolated inspiratory muscle training (IMT) with linear load greater than or equal to 30% of maximal inspiratory pressure (MIP) was considered as intervention. It could be compared to a control group (no training) or a placebo group (training load with less than 30% of MIP). (Barbalho-Moulim, Miguel Campos, & Costa, 2011) All data were extracted from full texts.

The Mesh descriptors were: Respiratory Muscles, Breathing Exercises, Muscles Strength; Diaphragm; Hypertrophy; Ultrasonography; Tomography, Magnetic Resonance Imaging, Biopsy. Besides these we also considered the following key words: Resistive Breathing; Inspiratory Muscle Training; Resistive Load; Incremental Load Threshold, Ventilatory Muscle Training, Respiratory Muscle Training, Diaphragm thickness; Imaging Diaphragm.

RISK OF BIAS

The risk of bias of the studies was assessed according to the Cochrane Handbook for Systematic Reviews of Interventions. (Higgins & Green, 2011), the items evaluated were: screening (randomization and allocation concealment), performing the method (blinding of participants and evaluators), detection (masking of outcome assessment), follow-up study (losses or deletions of volunteers during the study) and selective description of outcomes (selective information). The trial consisted of: high risk of bias (when there is no citation of the process); unclear risk of bias (citation without clarification) and low risk of bias (citation describing the operation mode).

DATA COLLECTION AND ANALYSIS

The data extraction was performed independently by 2 initials investigators (TDSR and HCMS), through a previously prepared form, including the following information: title, author, year, number of participants, eligibility criteria, characteristics of the groups, exclusions, intervention and evaluation of the risk of bias. At all stages of the methodological process of building the revision, the disagreements were always resolved involving a third investigator (AL).

SUMMARY OF STUDY RESULTS

The studies were tabulated for a later qualitative and quantitative analysis. We described characteristics of the population, including participants, intervention, performed protocol in the control group and results. Subsequently, data were combined to build a meta-analysis based on differences of means.

For the outcome of diaphragm thickness during contraction was performed a random effects meta-analysis and, for the outcome diaphragm thickness during relaxed, we performed a meta-analysis of fixed effects, but as the heterogeneity test with a significance level of 0.05 was achieved, we used the random effects model. The heterogeneity between studies was accessed through the Cochran Q test and I² test of Higgins (Higgins & Green, 2011) we considered significant for $p < 0.05$ and $I^2 > 30\%$. Statistical analysis was performed with RevMan software, version 5.1.0.

RESULTS

STUDY SELECTION

The search strategy was broad and resulted in 8779 titles. For duplicity, 217 titles were discarded. Of the remainder, 8541 were removed for not meeting inclusion criteria (Figure 1). The potentially eligible studies (21) were evaluated for their abstracts or full texts. Of these, 19 did not show the expected outcome (evaluation of diaphragmatic thickness). Finally, two articles were selected for final analysis.

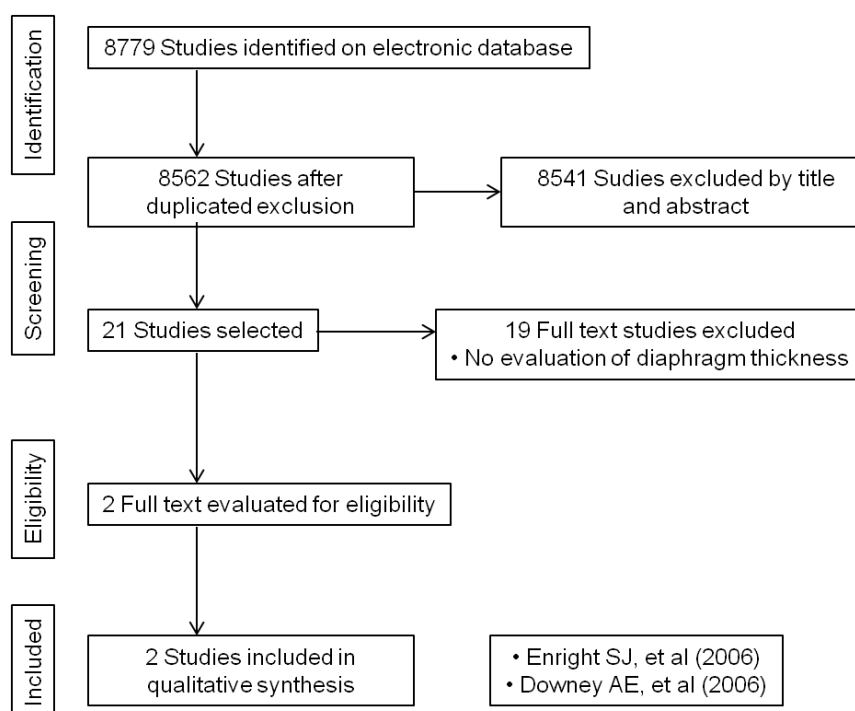


Figure 01. Search and selection of studies according to PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*).

STUDY CHARACTERISTICS

The selected studies were conducted in the UK (Enright, Stephanie Unnithan J, Heward, Withnall, & Davies, 2006) and the U.S. (Downey et al. 2007), involving a total of 35 volunteers of both sexes (Table 1). In one study (Downey et al., 2007) the control group was characterized by the use of a load of 15% of Maximal inspiratory pressure (MIP), while in another (Enright et al., 2006) the control group was maintained without intervention. There was heterogeneity in training protocols used between studies with respect to the duration and load used. Their characteristics are expressed in Table 1. Both studies measured diaphragm thickness at end-expiratory (functional residual capacity -FRC) characterizing it as relaxed thickness, and at the end of inspiration (total lung capacity-TLC), characterizing it as diaphragm thickness in contraction.

Table 1 Studies characteristics.

Author, year, country	Population	Included	Intervention Protocol	Control Group	Diaphragm Thickness Relaxed (FRC)	Diaphragm thickness in contraction (TLC)
Downey et al. 2007; USA (Downey et al., 2006)	Healthy young (18-21 years), non-smoking, normal lung function (spirometry), free of heart disease and/or lung disease, moderate physical activity	TG n=8 CG n=7 (7 women e 8 men)	Instrument: Threshold IMT ® Training: 4 weeks; Frequency: 5 days a week; Intensity: 50% of MIP In each session: 2 x 40 maneuvers maximal inspiration from the CRF; A weekly visit to the lab for load adjustment and guidance.	Load: 15% of MIP	TG= 2.66 ± 0.19mm CG= 2.06 ± 0.14mm p<0,05	TG= 3.14 ± 0.17mm CG= 2.60 ± 0.17mm p<0,05
Enright et al., 2006; U.K. (Enright, Stephanie J Unnithan et al., 2006)	Healthy young (18-25 years), moderate physical activity, no smoking, no evidence of pulmonary or metabolic disorders	TG n=10 CG n=10 (11 women e 9 men)	Instrument: Electronic Manometer (Electronic Software Respiratory Trainer, model RT2) Training: 8 weeks; Intensity: 80% of MIP Frequency: 3x per week In each session: 6 consecutive levels, with 6 forced inspirations. At each level the standing time between breaths progressively reduced: Level 1: 60s; Level 2: 45s; Level 3: 30s; Level 4: 15s; Level 5: 10s; Level 6: 5s; Automatic interruption (by software): Inability to achieve the minimum of 90% of the percentage determined in MIP.	No trainig	TG= 2.4 ± 0.4mm CG= 2.4 ± 0.7mm NS	TG= 4.6 ± 0.7mm CG= 3.9 ± 0.5mm p<0,05

MIP: Maximal inspiratory pressure; TG: Training Group; CG: Control Group; FRC: Functional Residual Capacity; TLC: Total lung capacity.

QUALITY AND RISK OF BIAS

All analyzed studies have clearly defined goals for their search. All studies cited, but only one describes the method used (Enright, Stephanie J Unnithan et al., 2006). The allocation concealment was not mentioned in either study, thus compromising the results. No study presented sample calculation or follow-up. Only one study promoted the blinding of participants (Downey et al., 2007). As shown in Figure 2.

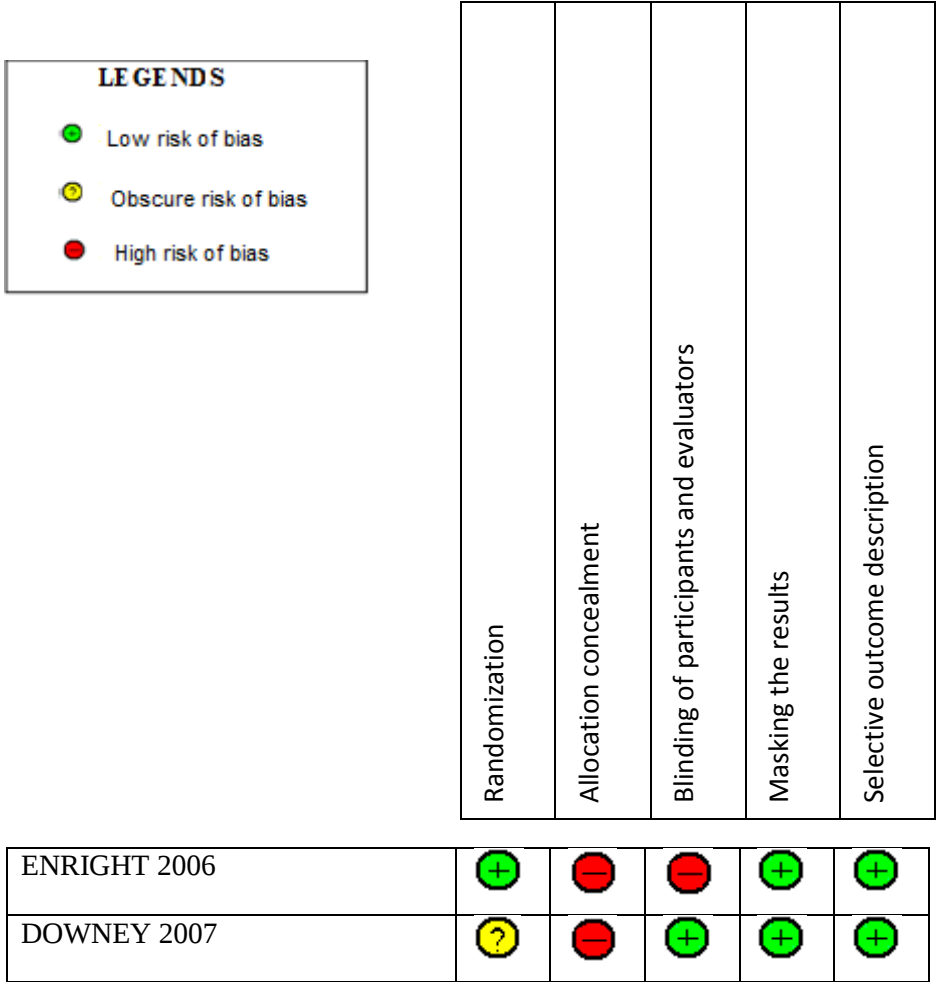


Figure 02. Methodological evaluation according to the *Cochrane Collaboration Reviewer's Handbook*, version 5.1.0.

QUANTITATIVE SYNTHESIS

After data analysis from the included studies, two meta-analyses were possible. The first involves the relaxed diaphragmatic thickness (FRC) outcome and the second involves the diaphragmatic thickness in contraction (TLC). The meta-analyses data are expressed in Figures 3 and 4.

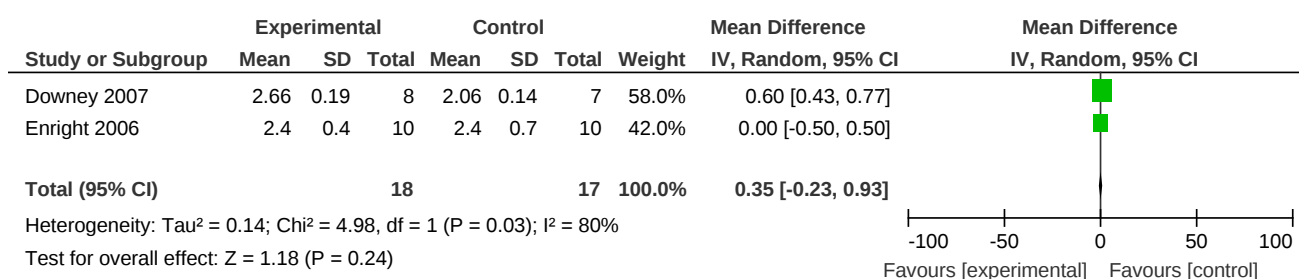


Figura 3. Forest Plot. Comparison of diaphragm thickness relaxed, between groups (random effect).

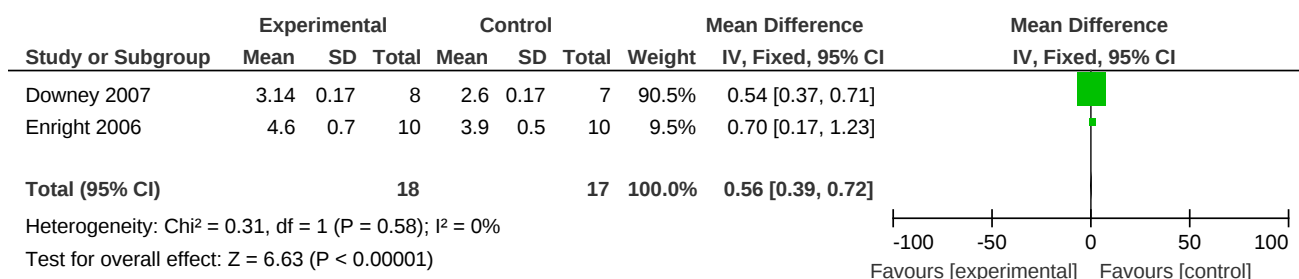


Figura 4: Forest Plot. Comparison of diaphragm thickness contracted, between groups (fixed effect)

DISCUSSION

This systematic review is first to assess the effects of inspiratory muscle training on the diaphragm thickness in healthy subjects. The findings of this review showed no statistical difference between the control and intervention groups in diaphragmatic thickness values at rest and in contraction after inspiratory muscle training.

Meta-analysis showed no effects of TMI for diaphragm thickness during contraction between groups. The observed homogeneity and low risk of methodological bias seen in the studies suggests that the small number of participants evaluated may have affected the results.

For the relaxed diaphragmatic thickness outcome (CRF) meta-analysis indicated no differences between the groups, demonstrating the lack of evidence to suggest training impact on this variable. However the studies that evaluated this outcome showed different training protocols, which resulted in a high heterogeneity between studies thus compromising the consistency of these findings, so the results should be analyzed cautiously.

The objective of a systematic review goes beyond the assessment of the outcome of an intervention. The assessment of methodological quality of studies emerges as the main goal, to seek the truth of the findings. The best way to minimize selection bias, ensuring the effect of treatment is the proper conduct of the process of randomization and allocation concealment. The overestimation of the treatment effect may be 40% when such items are improperly made (Bland & Altman, 1999; Altman & Schulz, 2001). Both studies in this review mentioned the random allocation, but only one described the method, lowering the risk of bias.

Blinding is as necessary as the randomization process because it decreases the likelihood that researchers' expectations regarding the benefit of treatment are transferred to participants (Day & Altman, 2000). From the studies included in this review only one cited masking and none of the studies included did the blinding of assessors of outcomes. The main limitation found in the current review was the limited number of studies assessing the thickness diaphragm after inspiratory muscle training.

The evidence-based practice determines the conscious use of scientific evidence to guide the choice of treatment combined with practical experience and the patient's choice (Borry, Schotsmans, & Dierickx, 2006). Accordingly, this review has shown that there is no sufficient evidence that inspiratory

muscle training to generate increased thickness diaphragm, however these results need to be investigated in future studies.

CONCLUSION

This Systematic Review showed that inspiratory muscle training does not generate detectable effects on diaphragmatic thickness in healthy subjects. But this finding should be treated cautiously because the number of studies included and the total number of participants evaluated were reduced. Thus, it is recommended that further clinical trials should be conducted with methodological rigor appropriate and larger samples in order to investigate the effects of inspiratory muscle training on the diaphragm thickness in healthy subjects.

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ANEXO 1 – FICHA DE AVALIAÇÃO DOS PACIENTES

UNIVERSIDADE FEDERAL DE PERNAMBUCO
DEPARTAMENTO DE FISIOTERAPIA
LABORATÓRIO DE FISIOTERAPIA RESPIRATÓRIA

Efeitos da técnica de liberação diafragmática na mobilidade do gradil costal e do diafragma em idosos com DPOC. Ensaio clínico controlado e randomizado.

Pesquisador : Taciano Dias de Souza Rocha

Nome: _____ Data de Nascimento: _____
____/____/____

Telefone: _____ Endereço: _____

Email: _____

Nome: _____

Etiologia: _____ Classe Funcional: _____ Grupo- I () C ()

Tabagismo: Sim () Não () Ex () – Anos () Cigarros/ dia () Parou há quanto tempo: _____

Medicamentos: _____

HDA. _____

1º DIA ____/____/____

EXAME FÍSICO

Peso	Altura	IMC	PA	FC	FR	SpO ₂
			x			

ESPIROMETRIA

		VEF ₁	CVF	PFE	FEF _{25-75%}	VEF ₁ /CVF	VVM
ANTES	MEDIDO						
	%						
	PREDITO						
DEPOIS	MEDIDO						
	%						
	PREDITO						

MANOVACUOMETRIA

Pi máx

	1ª Medida	2ª Medida	3ª Medida	4ª Medida	5ª Medida
ANTES					
DEPOIS					

Pemáx

	1ª Medida	2ª Medida	3ª Medida	4ª Medida	5ª Medida
ANTES					
DEPOIS					

Snipp

	1ª	2ª	3ª	4ª	5ª	6ª	7ª	8ª	9ª	10ª
ANTES										
DEPOIS										

ULTRASSONOGRAFIA**Volume Corrente**

	1ª Medida	2ª Medida	3ª Medida	4ª Medida	5ª Medida
ANTES					
DEPOIS					

Capacidade pulmonar total

	1ª Medida	2ª Medida	3ª Medida	4ª Medida	5ª Medida
ANTES					
DEPOIS					

COMENTÁRIOS

OEP (PRÉ/PÓS)**COMENTÁRIOS**

2º DIA ____/____/____

PA	FC	FR	SpO ₂
x			

COMENTÁRIOS: _____

3º DIA ____/____/____

PA	FC	FR	SpO ₂
x			

COMENTÁRIOS: _____

4º DIA ____/____/____

PA	FC	FR	SpO ₂
x			

COMENTÁRIOS: _____

5º DIA ____/____/____

PA	FC	FR	SpO ₂
x			

COMENTÁRIOS: _____

PA	FC	FR	SpO ₂
x			

		VEF ₁	CVF	PFE	FEF _{25-75%}	VEF ₁ /CVF	VVM
ANTES	MEDIDO						
	%						
	PREDITO						
DEPOIS	MEDIDO						
	%						
	PREDITO						

	1ª Medida	2ª Medida	3ª Medida	4ª Medida	5ª Medida
ANTES					
DEPOIS					

	1ª Medida	2ª Medida	3ª Medida	4ª Medida	5ª Medida
ANTES					
DEPOIS					

[illegible]

ULTRASSONOGRRAFIA**Volume Corrente**

	1ª Medida	2ª Medida	3ª Medida	4ª Medida	5ª Medida
ANTES					
DEPOIS					

Capacidade pulmonar total

	1ª Medida	2ª Medida	3ª Medida	4ª Medida	5ª Medida
ANTES					
DEPOIS					

COMENTÁRIOS

OEP (PRÉ/PÓS)

COMENTÁRIOS _____

ANEXO 2 - TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO



UNIVERSIDADE FEDERAL DE PERNAMBUCO

CENTRO DE CIÊNCIAS DA SAÚDE
DEPARTAMENTO DE FISIOTERAPIA

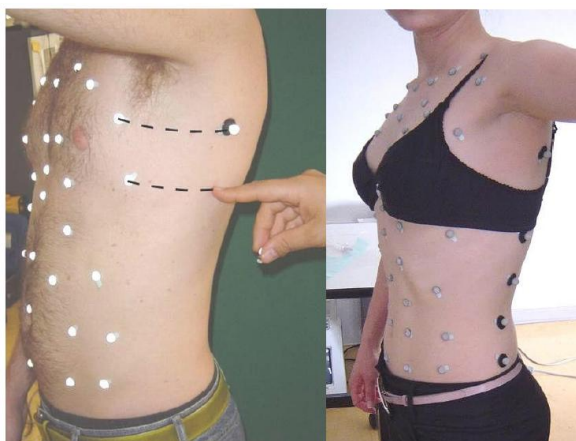
Termo de Consentimento Livre e Esclarecido – **Cópia do Voluntário**

Você está sendo **convitado** a participar da pesquisa: EFEITOS DA TÉCNICA DE LIBERAÇÃO DIAFRAGMÁTICA NA MOBILIDADE DO GRADIL COSTAL E DO DIAFRAGMA EM IDOSOS COM DPOC.

A sua participação não é obrigatória. A qualquer momento você pode desistir de participar e retirar seu consentimento. Sua recusa não trará nenhum prejuízo em sua relação com o pesquisador ou com a instituição, Universidade Federal de Pernambuco (UFPE). Caso aceite o convite, a participação nesta pesquisa consistirá em comparecer, com a frequência de três dias por semana, num total de seis sessões, ao Departamento de Fisioterapia da UFPE.

O objetivo deste estudo é registrar, após o uso da técnica de terapia manual chamada liberação diafragmática, a melhora da movimentação das costelas e do diafragma. Nesse método, com o voluntário deitado de barriga pra cima e relaxado, o avaliador faz contato leve das suas mãos, com as costelas do voluntário. A cada vez que o voluntário inspirar, o avaliador vai usar as mãos para acompanhar o movimento de subida das costelas, sem que isso gere dor. Isso ocorrerá em duas séries de dez respirações profundas, com intervalo de um minuto entre elas.

Para avaliar o movimento das costelas e do abdômen, será usado o exame de Pletismografia Optoeletrônica. Nesse exame, o voluntário respira de forma calma e profunda durante três minutos e câmeras ao redor da sala vão reconhecer o movimento dos marcadores reflexivos, colados por adesivo hipoalérgico no corpo do voluntário, gerando um modelo em 3D do tórax do voluntário. Esse exame não provoca dor no voluntário.



Para a avaliação dos ganhos funcionais será realizado o Teste de Caminhada de 6 minutos, no qual o(a) Sr. (Sr.^a) caminhará durante seis minutos em um corredor, tendo suas funções cardíacas e respiratórias monitoradas, a fim de estabelecer a distância máxima que é capaz de percorrer nesse período.

A mobilidade do músculo diafragma será avaliada pela Ultrasonografia. Nesse teste, o avaliador registrará imagens desse músculo por meio de um dispositivo em contato com a pele da barriga, sem causar qualquer dor nem desconforto.

As informações obtidas através dessa pesquisa serão confidenciais e asseguramos o sigilo sobre sua participação. Os dados não serão divulgados de forma a possibilitar sua identificação. Não feitas fotos dos rostos dos voluntários, nem mesmo em posições que denigrem sua imagem ou lhe deixem desconfortável. Você receberá uma cópia deste termo onde consta o e-mail e o telefone do pesquisador principal, podendo tirar suas dúvidas sobre o projeto e sua participação, agora ou a qualquer momento.

Riscos para o voluntário

- Sensação dolorosa momentânea, causada pelo contato das mãos do avaliador com o tórax do voluntário.
- Breve sensação de tontura decorrente do ciclo de 10 respirações profundas.

Benefícios para o voluntário

- Melhora da respiração com alívio da sensação de ar aprisionado no pulmão.
- Aumento da resistência às atividades do dia-a-dia, pela redução da fadiga respiratória.
- Melhora na mobilidade do tórax e do músculo diafragma, estimulando a circulação sanguínea.

Pesquisador Responsável

Taciano Dias de Souza Rocha - CREFITO 131552 - F

E-mail: taciano_rocha@hotmail.com

Rua Afonso Batista 223 apto. 603, Espinheiro.

Recife – PE. CEP 52021-020

Telefone: (81) 3031 – 9981

Contato com o Comitê de Ética em Pesquisa

Av. Prof. Moraes Rego s/n, Cidade Universitária, Telefone: (81) 2126 8588
Recife-PE, CEP: 50670-901

Declaro que entendi os objetivos, riscos e benefícios de minha participação na pesquisa:
EFEITOS DA TÉCNICA DE LIBERAÇÃO DIAFRAGMÁTICA NA MOBILIDADE
DO GRADIL COSTAL E DO DIAFRAGMA EM IDODOS COM DPOC e concordo
em participar.

Pesquisador Responsável

Data ____/____/____

ANEXO 3 – REGISTRO DO COMITÊ DE ÉTICA EM PESQUISA


SERVIÇO PÚBLICO FEDERAL
UNIVERSIDADE FEDERAL DE PERNAMBUCO
CENTRO DE CIÊNCIAS DA SAÚDE
Comitê de Ética em Pesquisa
Av. da Engenharia, s/n – 1º andar – Sala 4 – Cidade Universitária
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Ofício nº. 064/2013 - CEP/CCS/UFPE

Recife, 06 de março de 2013.

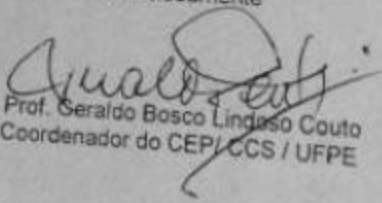
Ao
Fisioterapeuta Taciano Dias de Souza Rocha
Departamento de Fisioterapia - CCS/UFPE

Registro do SISNEP FR - 382860
CAAE – 0410.0.172.000-10
Registro CEP/CCS/UFPE Nº 415/10
Título: Efeito da técnica de liberação diafragmática na mobilidade do gradil costal e do diafragma em idosos saudáveis e com DPOC
Pesquisador Responsável: Taciano Dias de Souza Rocha

Senhor (a) Pesquisador (a):

O Comitê de Ética em Pesquisa Envolvendo Seres Humanos do Centro de Ciências da Saúde da Universidade Federal de Pernambuco (CEP/CCS/UFPE) recebeu em 01/03/2013 o relatório final do protocolo em epígrafe e considera que o mesmo foi devidamente aprovado por este Comitê nesta data.

Atenciosamente


Prof. Geraldo Bosco Lindoso Couto
Coordenador do CEP/CCS / UFPE