UNIVERSIDADE DE BRASÍLIA
FACULDADE DE CEILÂNDIA
PÓS-GRADUAÇÃO EM CIÊNCIAS E TECNOLOGIAS EM SAÚDE
PROGRAMA DE MESTRADO ACADÊMICO

LUCAS NOGUEIRA DE OLIVEIRA

Comparação Morfométrica Em Ressonância Magnética Dos Músculos Da Perna Em Pacientes Apresentando Síndrome Do Estresse Tibial Medial

Brasília/DF, 2023

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Dissertação desenvolvida na Faculdade de Ceilândia da Universidade de Brasília, como pré-requisito para diplomação em Mestre pelo Programa de Pós-Graduação em Ciências e Tecnologias em Saúde – PPGCTS - Universidade de Brasília – UnB.

Área de concentração: Mecanismos Básicos e Tecnologias em Saúde.

Linha de pesquisa: Mecanismos moleculares e funcionais da Saúde

Orientadora**:** Dra. Rita de Cássia Marqueti Durigan

Brasília/DF 2023

Ficha catalográfica

NN778c Nogueira de Oliveira, Lucas

Comparação Morfométrica Em Ressonância Magnética Dos Músculos Da Perna Em Pacientes Apresentando Síndrome Do Estresse Tibial Medial / Lucas Nogueira de Oliveira; orientador Rita de Cássia Marqueti Durigan; co-orientador João Luiz Quagliotti Durigan. -- Brasília, 2023. 46 p.

Dissertação (Mestrado em Ciências e Tecnologias em Saúde) - Universidade de Brasília, 2023.

1. Síndrome do Estresse Tibial Medial. 2. Efeito da tração periosteal ou efeito tenda na margem posteromedial da tíbia. 3. Avaliação por ressonância nuclar magnética da morfometria dos músculos da perna. I. Marqueti Durigan, Rita de Cássia, orient. II. Quagliotti Durigan, João Luiz, co-orient. III. Título.

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BANCA EXAMINADORA

_____

Profª. Dra. Rita de Cássia Marqueti Durigan
Faculdade de Ceilândia - Universidade de Brasília - UnB
(Presidente)

_____

Profª. Dr. Jose Aderval Aragão
Departamento de Morfologia – Universidade Federal de Sergipe - UFS

_____

Prof. Dr. Rodrigo Scattone da Silva
Universidade Federal do Rio Grande do Norte - UFRN/FACISA

Brasília/DF, 2023

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Lista de abreviaturas e siglas

UnB-FCE - Universidade de Brasília, Faculdade de Ceilândia

PPGCTS - Programa de Pós-graduação em Ciências e Tecnologias em Saúde

LaPlast - Laboratório de Plasticidade Musculotendínea

LAM - Laboratório de Análises Moleculares

SETM - Síndrome do estresse tibial medial

DMPMT - dor na margem posteromedial da tíbia

TA - Tibial anterior/ Tibialis anterior

GT - Gastrocnêmio/Gastrocnemius

SL - Sóleo/Soleus

TP - Tibial posterior/Tibialis posterior

FLD - Flexor longo dos dedos

FLH - Flexor longo do hálux

ASTA - Área de secção transversal axial

VM - Volume muscular

CPP - Compartimento posterior profundo

RNM - Ressonância Nuclear Magnética

DPM - Dor posteromedial

FHL - Musculo Flexor Longo do Hálux

MTSS - Medial tibial stress syndrome

MRI - Magnetic Resonance Imaging

DPC - Deep posterior compartment

ACSA - Axial cross-sectional area

PTB - Posteromedial tibial border

ROI - Region of interest

TSE - Turbo Spin Echo

SPC - superficial posterior compartment

EDL - Extensor Digitorum Longus

ELH - Extensor Hallucis Longus

FDL - Flexor Digitorum Longus

FHL - Flexor Hallucis Longus

FL - Fibularis

MANOVA - Multivariate Analysis of Variance

ICC - Intraclass Correlation Coefficient

1. AGRADECIMENTOS

Estes últimos anos não foram fáceis, e só pude completar esta tese com apoio incondicional das seguintes pessoas:

Aos meus pais e irmã e tia, Pedro, Beatriz, Lara, Bebel, que são alicerces da minha mente e que auxiliaram incondicionalmente nos momentos difíceis da minha carreira profissional e acadêmica.

Aos meus orientadores, professores e colegas da Universidade de Brasília, em especial a Dra. Rita Marqueti Durigan, que sempre me estimulou a seguir firme no propósito e acompanhou de perto meu desenvolvimento científico neste programa de pós-graduação, e os orientadores Dr. João Durigan e Dr. Henrique Mansur, os quais teceram comentários e orientações fundamentais para o correto direcionamento do que viria ser esta tese, participando diretamente nesta construção.

Aos meus preceptores do programa de residência médica em Ortopedia e Traumatologia, Dr. Ricardo Frade, Dr. Edmon Fernando, Dr. Cid Jorge, Dr. Fernando Borges, Dr. Eduardo Barroso, Dr. Luiz Sarmanho, que são bases e exemplos para minha carreira profissional. Em especial ao Dr. Vinicius Carvalho, que não somente permitiu eu realizar o Mestrado, como sempre foi suporte para que continuasse prosperando no curso.

Aos meus amigos da residência médica, Dr. Eduardo França, Dr. Fernando Melo, Dra. Silvia Almeida, sem vocês eu não conseguiria conciliar o aprendizado dos programas.

Às colegas da Clínica Villas-Boas que foram peças chave para que a coleta de dados do estudo fosse possível em especial a Dra. Caroline Sanchez que possibilitou a coparticipação da clínica.

Por fim, a todos amigos e família que são suporte constante e dividem comigo os dias, a sanidade mental é uma linha tênue que depende de um círculo virtuoso de pessoas onde só o amor fornece energia para seguirmos firmes em nossos propósitos.

2. INFORMAÇÕES GERAIS

2.1 Instituições da pesquisa

Universidade de Brasília, Faculdade de Ceilândia (UnB-FCE), Programa de Pós-Graduação em Ciências e Tecnologias em Saúde (PPGCTS), Laboratório de Plasticidade Musculotendínea (LaPlast), Laboratório de Análises Moleculares (LAM),
Campus Universitário, S/N, Centro Metropolitano, Brasília, DF
CEP: 72220-275
Fone: (61) 3107-8418

Clínica coparticipante:
Clínica Villas Boas
SHLS 716 Bloco F BL D - Asa Sul, Brasília, DF.
CEP: 70390-901
Fone: (61) 2191-5050

2.2 Equipe de trabalho:

Discente: Lucas Nogueira de Oliveira (PPGCTS)

Profa. Rita de Cássia Marqueti Durigan (LAM)

Prof. João Luiz Quagliotti Durigan (LaPlast)

Dr. Henrique Mansur Gonçalves (Hospital Santa Helena – Rede D'or)

Dra. Caroline Ribeiro Sanchez (Radiologia Villas Boas)

Dra. Andressa Beatriz Beltrão Rosa (Radiologia Villas-Boas)

2.3 RESUMO

INTRODUÇÃO: A prática de corrida torna-se cada vez mais frequente devido os benefícios comprovados à saúde. Dessa forma, o número de lesões associadas a esta modalidade está em constante aumento. Uma das lesões frequentes é a Síndrome do estresse tibial medial (SETM). As hipóteses principais para ocorrência da SETM estão centradas na contração excêntrica muscular excessiva o que pode levar a tração periosteal. Considerando o aumento da incidência atual de dor nos membros inferiores nessas populações de atletas, este estudo objetivou estudar os aspectos volumétricos dos músculos do compartimento posterior profundo (CPP) da perna por meio da Ressonância Nuclear Magnética (RNM) de indivíduos que apresentaram SETM. **MÉTODOS**: Um estudo descritivo observacional de RNM foi conduzido para determinar presença ou ausência de diferenças nos aspectos volumétricos dos músculos do CPP da perna entre indivíduos normais e com SETM. Foram descritos os volumes, áreas axiais de secção transversa através de estudos de RNM usando o aparelho PHILIPS Ingenia 3 Tesla HP (Amsterdam, NL). Trinta e dois participantes foram divididos em dois grupos: grupo SETM e grupo Controle. **RESULTADOS**: O CPP apresentou uma diferença de volume superior de 0,41 cm3/kg3/4 no grupo MTSS (traço de Pillai = 0,280; Z (3, 26) = 3,367; p = 0,034). Essa diferença deveu-se ao FHL, conforme demonstrado pela subsequente análise de variância univariada (ANOVA), que demonstrou um volume normalizado superior de 0,55 cm3/kg3/4 no grupo MTSS em comparação com o grupo controle (F (1, 28) = 5,772; p = 0,023). Não houve associação entre gênero e MTSS em nosso estudo (X2(1) = 0,100; p = 0,752). **CONCLUSÃO**: O músculo FLH demonstrou aumento de volume nos participantes com SETM.

Palavras-chave: SETM; RNM; Volume muscular; compartimento posterior profundo

2.3 Abstract

INTRODUCTION: Running as a hobby and component of exercise routines has become increasingly popular due to its proven positive health effects. Therefore, the number of injuries associated with this exercise method has increased. One of the most frequent injuries is medial tibial stress syndrome (MTSS). The main hypothesis of the causes for MTSS are centered in excessive muscle eccentric contraction, which could lead to periosteal traction. Considering the increased incidence of lower limb pain in these populations, our study aimed to understand the volume of the lower leg deep posterior compartment (DPC) muscles through magnetic resonance imaging (MRI) analysis of individuals presenting MTSS. **METHODS:** An observational measure MRI study was conducted to determine the presence or absence of difference in the morphological aspects of the DPC muscles and tendons. An MRI descriptive muscle volume and tendons axial cross-sectional area (ACSA) measurement was conducted using PHILIPS Ingenia 3 Tesla HP (Amsterdam, NL) device. Thirty-two individuals were separated into two groups: MTSS group and Control group. **RESULTS**: The DPC showed a superior volume difference of 0.41 $cm^3/kg^{3/4}$ in the MTSS group (Pillai's trace = 0.280; Z (3, 26) = 3.367; p = 0.034). This difference was due to the FHL as shown by the subsequent univariate Analysis of Variance (ANOVA), which demonstrated 0.55 $cm^3/kg^{3/4}$ superior normalized volume in the MTSS group compared to the control group (F (1, 28) = 5.772; p = 0.023). There was no association in gender with MTSS in our study ($X^2(1) = 0.100$; p = 0.752). **CONCLUSION:** The Deep compartment muscle FHL showed an increased muscle volume.

Key words: MTSS; MRI; Muscle Volume; deep posterior compartment

3.0 REFERENCIAL TEÓRICO:

A prática de corrida de rua é frequente e o número de adeptos a essa modalidade esportiva está em constante aumento, pois sabe-se da sua facilidade de treino e dos seus benefícios à qualidade de vida (1–3). Consequentemente, o número de lesões decorrentes dessa prática desportiva entre atletas amadores e profissionais aumentou (4).Estima-se que 55% dos corredores de rua apresentem ao menos uma lesão por ano (5).

Aprimorar conhecimento sobre lesões dos corredores é de suma importância tendo em vista o supracitado. A SETM é caracterizada por dor na margem posteromedial da tíbia (DMPMT) associado a um exame de imagem (ressonância nuclear magnética ou cintilografia óssea) que determina edema periosteal ou até fraturas com deslocamento franco entre músculo e periósteo (6,7).Outros estudos, entretanto, mencionam que a SETM é distinta das fraturas causadas por estresse repetitivo e que nem sempre há continuidade na evolução da síndrome a essas (8–11). Os principais fatores de risco para o surgimento da SETM são: ser do sexo feminino, ter sobrepeso ou obesidade, lesões anteriores, maior rotação externa do quadril com esse em flexão e maior valor no resultado do teste de queda do osso navicular (12–14).

Uma análise de cerca de 2000 lesões da perna associadas à prática desportiva demonstrou que a SETM é a lesão mais frequente, o que a define como um dos principais diagnósticos diferenciais de DMPMT (4). O principal sintoma clínico é a DMPMT após palpação em 5 centímetros ao longo dessa ou quando paciente refere dor nos dois terços distais da mesma margem após prática de atividades físicas (15). As hipóteses etiopatogênicas estão centradas na fraqueza muscular, causando a incapacidade de absorção do impacto pelo músculo e a transmissão direta desse ao osso (16). Há também a teoria da tração do periósteo devido a contração muscular excessiva, o que conduz à periostite e consequentemente à dor, além da hipótese do acelerado remodelamento ósseo em resposta ao esforço repetitivo. Nesta última, a atividade osteonal produz um novo periósteo como reforço, contudo, caso a atividade osteoclástica exceda a média da atividade osteoblástica, podem surgir microfraturas no osso cortical (17,18).

A fim de melhor entendimento das hipóteses etipatogênicas da SETM, deve-se observar a cinemática da corrida. Nesta e em sua análise biomecânica, o músculo tibial anterior (TA), o extensor longo dos dedos e o extensor longo do hálux se contraem isometricamente para manter o pé elevado e quando a perna estiver perpendicular ao solo, esses músculos contraem-se concentricamente para fazer a dorsiflexão e inversão do pé, preparando-o para o contato com o solo. Na fase do balanço, o TA gera a única atividade muscular significativa no tornozelo e pé,

mantendo o pé elevado evitando que os dedos caiam enquanto o membro faz o balanceio (19). Já na origem biomecânica da periostite, cerne de uma das hipóteses de causa da SETM, os músculos supracitados não estão relacionados. Descreve-se que a contração excêntrica dos músculos gastrocnêmio (GT), sóleo (SL), tibial posterior (TP), flexor longo dos dedos (FLD) e flexor longo do halux (FLH) durante a fase de apoio resistindo aos movimentos pronadores da região médio-tarsal e subtalar do pé podem provocar efeito tenda na fáscia tibial o que causa tração em sua inserção na borda póstero-medial da tíbia (1). Este efeito foi primeiramente teorizado como uma tração semelhantemente à fascite plantar, porém sendo transmitida a partir dos músculos do CPP da perna para a fascia tibial, a qual possui inserção em toda borda posteromedial da tíbia (1,20). Neste contexto Saeki et al. (2017) observaram que há aumento da força de flexão plantar na primeira articulação metatarsofalangeana para evitar a DMPMT nos indivíduos com SETM, o que determina maior atividade dos músculos do CPP nesses (21).

Apesar de estarem descritas essas alterações de forças musculares da perna em indivíduos com SETM, não há descrição na literatura atual de como se comporta a morfologia dos músculos envolvidos na síndrome e seus respectivos tendões. Sabe-se que a força muscular depende de alguns fatores, como a razão de inervação (número de fibras por unidade motora), tamanho das fibras musculares, características dos miofilamentos e da área de secção transversal axial (ASTA) dos músculos (22,23). Além disso, os tendões humanos possuem capacidade de responder ao aumento da carga mecânica que devem suportar de algumas formas. Descrevem-se duas formas principais de capacidade adaptativa de um tendão após aumento na demanda de carga: aumento da sua rigidez ou hipertrofia da sua ASTA (24–26). Em geral a mudança da rigidez de um tendão pode ser observada mais cedo em programas de treinamento enquanto o aumento da ASTA é esperado em uma resposta adaptativa a longo prazo (27–29).

A Ressonância Nuclear Magnética (RNM) passou a ser indicada como exame complementar para diagnóstico das lesões por estresse da tíbia e para a SETM, pois pode demonstrar a existência de edema periosteal ou medular, uma vez que as radiografias demonstram somente sinais de fraturas (7,30). Recentemente, a ressonância magnética é citada como exame complementar padrão-ouro para diagnóstico da SETM e lesões por estresse em detrimento da cintilografia óssea, pois essa apresenta excelente resolução anatômica das estruturas ósseas e das partes moles, além de não expor o paciente às radiações ionizantes (2). O estudo de RNM possibilita a estratificação do processo sindrômico da SETM e autores demonstraram o acometimento gradativo de edema periosteal que concorre ao edema de medula óssea, além de mencionar as fraturas por estresse como estágio final das lesões por estresse (7).

Bergman et al. (2004), contudo, mencionaram, após estudar indivíduos que realizavam exercícios físicos intensos e que apresentavam edema periosteal e da medula óssea, não haver evolução da SETM às fraturas por estresse (9).

Alterações de volume muscular e a ASTA em indivíduos acometidos por SETM são desconhecidas até o momento. O estudo por imagem de RNM permite aferição de volume muscular (VM) por meio de técnicas de segmentação que tipicamente dependem de um operador manualmente delinear o contorno muscular de uma ASTA para o cálculo e então repetir o processo em todos os demais cortes transversos (*slices*) obtidos no estudo (31). O valor da ASTA possui confiabilidade descrita na literatura quando obtido através de cortes axiais da RNM e descreve-se que no ventre muscular de um determinado músculo é encontrado o maior valor da AST (32). Alguns autores puderam determinar correlação de somente uma ASTA com o VM total para os músculos GT, SL e TA, estimando-se assim o VM de forma mais rápida (33–35). Outros, construíram para os extensores, flexores e adutores da coxa (36,37). Essa correlação, entretanto, pode não ser precisa para análise em outros estudos que necessitem de dados com acurácia (31). Em geral, as técnicas manuais de segmentação de sucessivas ASTAs são reprodutíveis (38).

Em uma revisão sistemática, autores avaliaram a qualidade metrológica, validade e a confiabilidade de diversas técnicas de mensuração volumétrica de músculos em indivíduos considerados saudáveis ou com lesões objetivando saber a reprodutibilidade dessas (39). A técnica selecionada para este estudo foi a de segmentação manual em um número reduzido de *slices*, que é a única demonstrada a partir da supracitada revisão que foi considerada válida, confiável, reprodutível e com excelente qualidade metrológica para os músculos da perna. Nesta técnica, deve-se realizar medição da ASTA de *slices* que distam entre si até 3,1 cm e utilizar-se da fórmula do cone truncado para estimativa do volume entre *slices* (40). A utilização desta técnica depende da escolha do número de *slices* e da escolha da forma de cálculo do volume específicos para cada músculo com intenção de se obter erro pré-determinado. Porém, para pesquisas científicas com intenção de minimizar a chance de erros, além de pré-determinar a existência desse, as técnicas que utilizam maior número de *slices* podem dirimir eventuais problemas, como a avaliação da AST somente nas extremidades dos músculos o que pode acarretar medição subestimada dos volumes desses (41).

Dessa forma, procura-se utilizar protocolos que determinem um número adequado de *slices*. Um estudo delimitou forma de segmentação manual para todo membro inferior e descreveu o número padronizado de *slices* para avaliação do VM (42). Esse, propôs que a

utilização de 20 *slices* para todo o membro inferior, cada um com 5 mm de espessura. Outrossim, autores também propuseram o número adequado de *slices* para mensuração de VM (em mensuração do quadríceps femoral utilizando slices de 9 mm) e descreveram que intervalos de até 3,1 cm entre *slices* forneceriam precisão adequada, inclusive podendo esse valor ser utilizado para as demais aferições anatômicas do membro inferior, devendo a AST de cada *slice* ser multiplicada por sua espessura somados ao volume do espaço entre slices que correponde a estimativa da fórmula do volume de um cone truncado, sendo esta técnica considerada eficiente no quesito tempo necessário para a obtenção da estimativa volumétrica dos músculos com precisão adequada (40).

Além das técnicas manuais de segmentação, há possibilidade de utilização de softwares para segmentação automática de forma apropriada. Atualmente, a melhor forma de se obter imagens da RNM para segmentação automática é utilizando a técnica Two-point Dixon (43). Através dessa, pode-se produzir imagens com separação *water-only* e *fat-only* por meio de aquisição de duplo-eco e, assim, a definição dos tecidos complexos estará em melhor resolução (44). Então, deve-se desenvolver 4 passos para obtenção do VM descritos em uma revisão da literatura recente, a qual demonstrou essa forma de mensuração para os músculos da coxa (45). Os autores, entretanto, explanaram na discussão que, quando o objetivo do estudo for obter valores absolutos dos VMs, principalmente para estudos transversais, deve-se ter cautela uma vez que os dados obtidos dessa forma não são intercambiáveis entre as técnicas manuais e automatizadas (45). Desta forma, uma técnica manual foi utilizada para se determinar os volumes musculares estimados, conferindo segurança as comparações entre grupos de indivíduos considerados portadores de SETM e indivíduos não acometidos pela síndrome.

3.1 Objetivos:

Este estudo objetivou mensurar, descrever e analisar os aspectos morfométricos do compartimento posterior profundo da perna (volumes musculares, ASTA musculares, ASTA dos tendões) e analisar comparativamente a exames de indivíduos com laudos descritivos normais realizados por médicos especialistas em radiologia, por meio de RNM uma vez que esta é considerada o padrão ouro para esses tipos de mensurações (46,47). Ressalta-se a escassa literatura acerca da avaliação morfológica e volumétrica por RNM desses grupos musculares em indivíduos portadores da SETM aliado ao fato de que deverá haver mudanças morfométricas do CPP da perna uma vez que já se descreveu alterações de força nesses. Como objetivos secundários, realizaram-se comparações dos demais grupos musculares da perna os quais não devem apresentar alterações significantes e dos dados sociodemográficos presentes em

questionários preenchidos pelos pacientes anteriormente a realização de cada exame de RNM da perna.

3.2 Hipóteses:

Observar-se-á alteração morfométrica no compartimento posterior profundo da perna em participantes do grupo SETM uma vez que há aumento de força desses músculos devido ao estresse relacionado ao efeito tenda da fáscia tibial. Gênero feminino apresentará maior frequência no grupo SETM.

4.0 MANUSCRITO:

Lower Leg MRI Muscles Morphometric Comparison in Individuals Presenting Medial Tibial Stress Syndrome

4.1 Introduction

Running as a hobby and component of exercise routines has become increasingly popular due to its proven positive health effects.(3,48) Therefore, the number of injuries associated with this exercise method and others has increased substantially amongst recreational and professional athletes.(4) Nearly 15% of all injuries described in sports medicine are related to tibial pain, over 60% of all pain in athletes occurs in the lower limbs, and about 55% of runners experience an injury at least once per year.(5,49) One of the most frequent injuries is medial tibial stress syndrome (MTSS), which has a cause and effective relationship with running activities.(6,50) It has an incidence of between 4% and 35% in the athletic and military population.(18,51) MTSS is diagnosed by palpation of the posteromedial tibial border (PTB) that elicits pain or when an individual reports exercised-induced pain in the distal two-thirds of the PTB, both of which are associated with a Magnetic Resonance Imaging (MRI) exam describing periosteal edema or stress fractures.(6,7,15,52,53) However, some reports state that stress fractures are different entities and there is no natural evolution from MTSS to stress fractures.(8–11) Risk factors for MTSS include the feminine gender, age, and

patterns of lower limb kinematics (greater flexed hip external rotation in males and positive navicular drop test). (12–14,50)

The main hypothesis of the causes for MTSS are centered on tibial microfractures by repetitive movements, muscle weakness creating an inability of adequate impact absorption, and excessive muscle eccentric contraction, which could lead to periosteal traction (bone overload injury), consequently, regional inflammatory pain.(16–18,54) Biomechanical aspects of the running gait related to the lower leg deep posterior compartment (DPC) muscles were demonstrated as a possible cause of tenting effect at the distal tibial fascia, which leads to increased tension at its posteromedial insertions.(1) Also, one study reported that there is increased maximal voluntary isometric contraction torque for plantar flexion of the first metatarsophalangeal joint related to extrinsic deep flexors of the foot in patients with MTSS.(21)

Today, MRI exam is considered gold-standard for diagnosing MTSS. Once, a medical doctor can describe the syndromic process of the disease in its initial stages.(2,7) The MRI can access muscles and tendons axial cross-sectional areas (ACSA) through manual segmentation techniques where a region of interest (ROI) delimitated in computational software can retrieve an area value.(32) There is a possibility of achieving a muscle volume estimated value by continuously measuring ACSAs and summing all returned MRI slices volumes.

It is known that the etiopathology of MTSS is still a mystery, with some partially accepted theories. The tenting effect theory could help to understand the tibial fascia traction role being the origin of pain for MTSS as it was hypothesized that it could be similar to the plantar fasciitis etiopathology development.(1) Nevertheless, there is still a knowledge gap on how the morphological aspects of leg muscles behave *in vivo* to create the tenting effect. Identifying the exact risk factors for the development of MTSS is essential for the future development of preventive measures.(55) To our knowledge, there is no literature description

of the leg muscles volumes and tendons ACSA of individuals presenting MTSS in their MRI exams.

Considering the high number of recreational and professional athletes and the increased incidence of lower limb pain in these populations, our study aimed to help understand the tenting effect theory on the posteromedial tibial fascia insertion through morphological leg DPC muscles MRI analysis and their tendons of individual presenting MTSS. We sought to compare the results of the DPC muscle and tendon volumes and maximum ACSA measurements, which appears to be related to the tenting effect, with individuals presenting normal descriptive leg MRI reports.

4.2 Methods

Study design

This work received approval from the local research ethics committee (protocol xxxxxxxxx) and followed the Declaration of the World Medical Association for human studies. An observational measure and blinded raters' study was conducted to determine the presence or absence of difference in the morphological aspects of the DPC muscles and tendons. Exploratory data of all other muscles and tendons of the lower leg were also gathered. Data were collected retrospectively from a database of MRI exams and pre-exams questionnaires in a private radiology clinic of the Brazil Federal District ranging from 2018 to 2022.

Participants

An MRI descriptive report database search was conducted in a radiology clinic using the Boolean operators: "Lower Leg" AND "MTSS" AND "3 tesla" AND "Philips Ingenia". This search returned 32 legs MRI MTSS positive exams. Eighteen participants with MTSS were enrolled in this study after applying the inclusion and exclusion criteria based on the pre-exam questionnaires. The inclusion criteria were participants age between 15 and 50 years with

MTSS diagnosis. Patients with a history of previous lower limb surgery, pregnancy, lower leg fractures, recent trauma history, neuromuscular disorders, undergoing any systemic chronic disease treatment, and describing no pain in the posterior or medial regions of the leg were excluded. A control group was formed with a convenience sample of the most recent twenty MRI exams using the parameter "normal" instead of the MTSS parameter which returned only normal descriptive MRI lower leg reports made by two senior radiologists. After the investigation of the pre-exam questionnaires, only 12 were eligible for statistical analysis, once the others declared having pain in the posterior and medial regions of the lower leg, which could be described as MTSS even with an MRI normal report.

Image acquisition

The PHILIPS Ingenia 3 Tesla HP (Amsterdam, NL) device was selected for this study. All MRI were performed to determine the presence of MTSS, and the lower leg muscles and tendons ACSA were obtained along its length. Scanning time lasted approximately 30 minutes per patient. There were axial, coronal, and sagittal sequences for all exams. Participants laid supine with the hip and knee extended and the ankle fixed in a relaxed position. The selected sequence for analysis was the Turbo Spin Echo (TSE) axial T1-weighted, considered the best anatomical sequence.(39) The protocol was an acquisition time of 190.75 seconds, TR of 755, TE of 13.5, matrix 364 x 280, FOV of 400x200 mm, Voxel of 0.4x0.4, a thickness of 6 mm, and cutting range of 0.4. An 8-channel receive-only multi-coil was used as a receiver. Imaging was obtained continuously from the distal third of the femur to the lowest aspect of the ankle. All included participants were examined using the same image acquisition technique in either of two devices of the same specifications.

Segmentation technique

The segmented muscles and tendons were Tibialis anterior (TA), Extensor Digitorum Longus (EDL), Extensor Hallucis Longus (ELH), Tibialis posterior (TP), Flexor digitorum

longus (FLD), Flexor Hallucis Longus (FLH), Fibularis (FL) (*longus* and *brevis* cojoined in one measure), Soleus (SL), and Gastrocnemius (GT) (both heads in one measure) **(Figure 1)**.

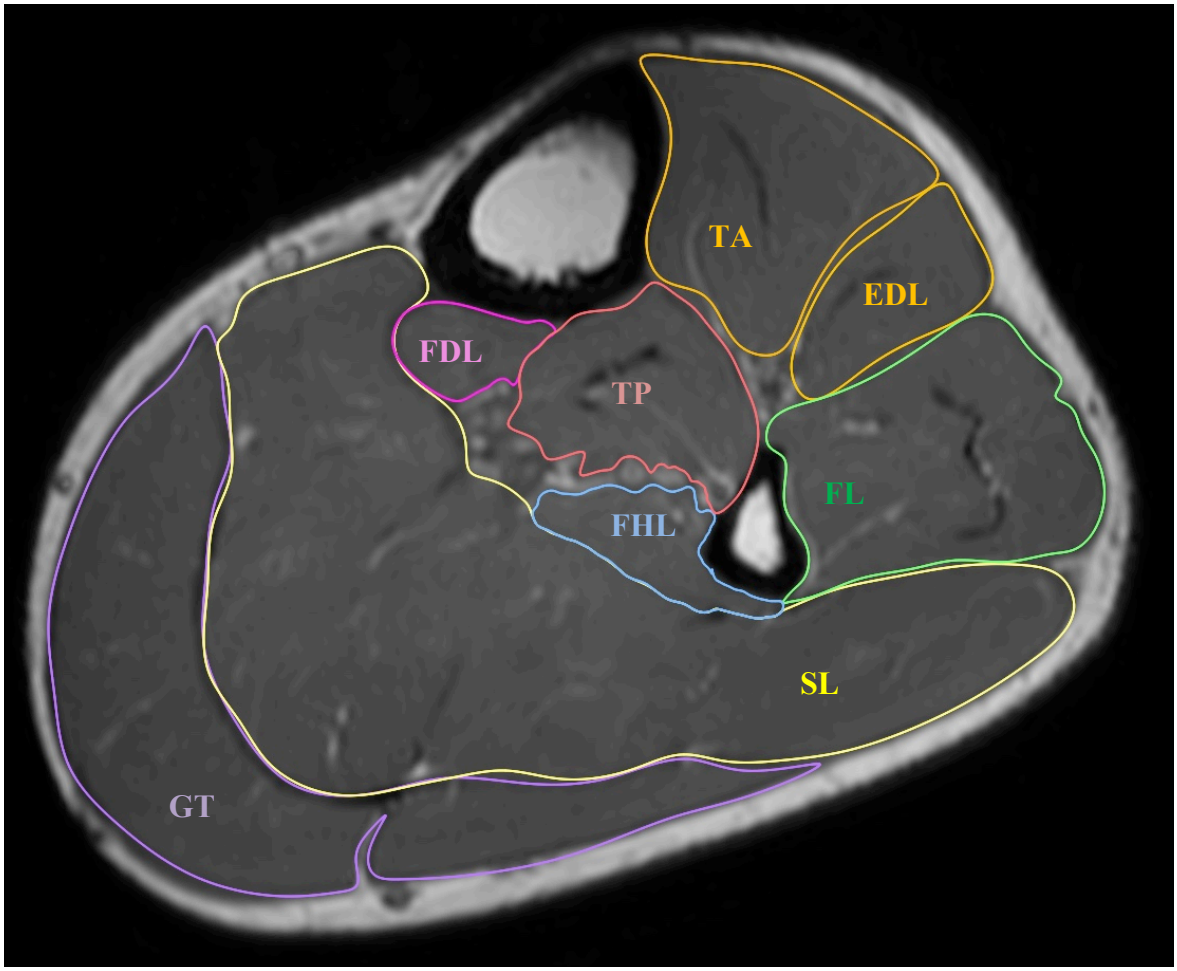

FIGURE 1: Lower leg muscles axial cross-sectional areas manually segmented. **TA,** Extensor digitorum longus; **EDL**, Extensor digitorum longus; **FL**, Fibularis Longus and brevis; **FHL**, Flexor hallucis longus; **FDL**, Flexor digitorum longus; **TP**, Tibialis posterior; **SL**, Soleus; **GT**, Gastrocnemius.

The muscle length was segmented in the Axial T1-weighted turbo-spin-echo image using the software OsiriX® (Pixmeo SARL, version 2.5.1, Switzerland). Some authors described methods with reduced segmentation of slices to estimate the total muscle volume and reported the accuracy of the muscles volumes estimates.(31,39,40,42,56,57) Reports mentioned that slices ranging from 5 mm to 9 mm of thickness with a 1.0 cm to 3.1 cm distance interval

between slices measured could provide adequate precision to muscle volume estimations.(40–42,58,59) Thus, it seems secure to measure muscle volume by summarizing slices volumes and the approximate volumes of 2.4 cm gaps between the slices (achieved using a truncated cone formula).(40)

The ACSA records were obtained in an interval of 2.4 cm between slices using a manually assigned vector-field boundary outliner software tool. The rater defined the silhouettes manually creating a 2-D ROI for each muscle and tendon ACSA. The first ACSA measured was obtained throughout the knee midline articular space just above the tibial spine. The last ACSA measured was obtained in the inferior aspects of the ankle, where all lower leg muscles had already vanished and there were only their tendons. The tracing technique delimits the entire visible area of the muscle or tendon, excluding the peritendinous sheath. Subsequently, the software calculated the ACSA.(31,32,38–42,58,59) The maximum ACSA (in mm^2) of the muscles and tendons was obtained after three subsequently measurements along the three maximum subjective observed ACSA of each structure, and the major value was considered for statistical analysis. Muscle volumes were accessed by summarizing the slices volumes and the volumes of 2.4 cm gaps between the slices using a truncated cone formula (**Figure 2**).(40) For all measurements, two independent raters, both physicians, being one an orthopedics resident (rater 1) and the other a radiologist resident (rater 2) were trained independently by a senior radiologist. After being declared capable, both raters initiated the segmentation process.

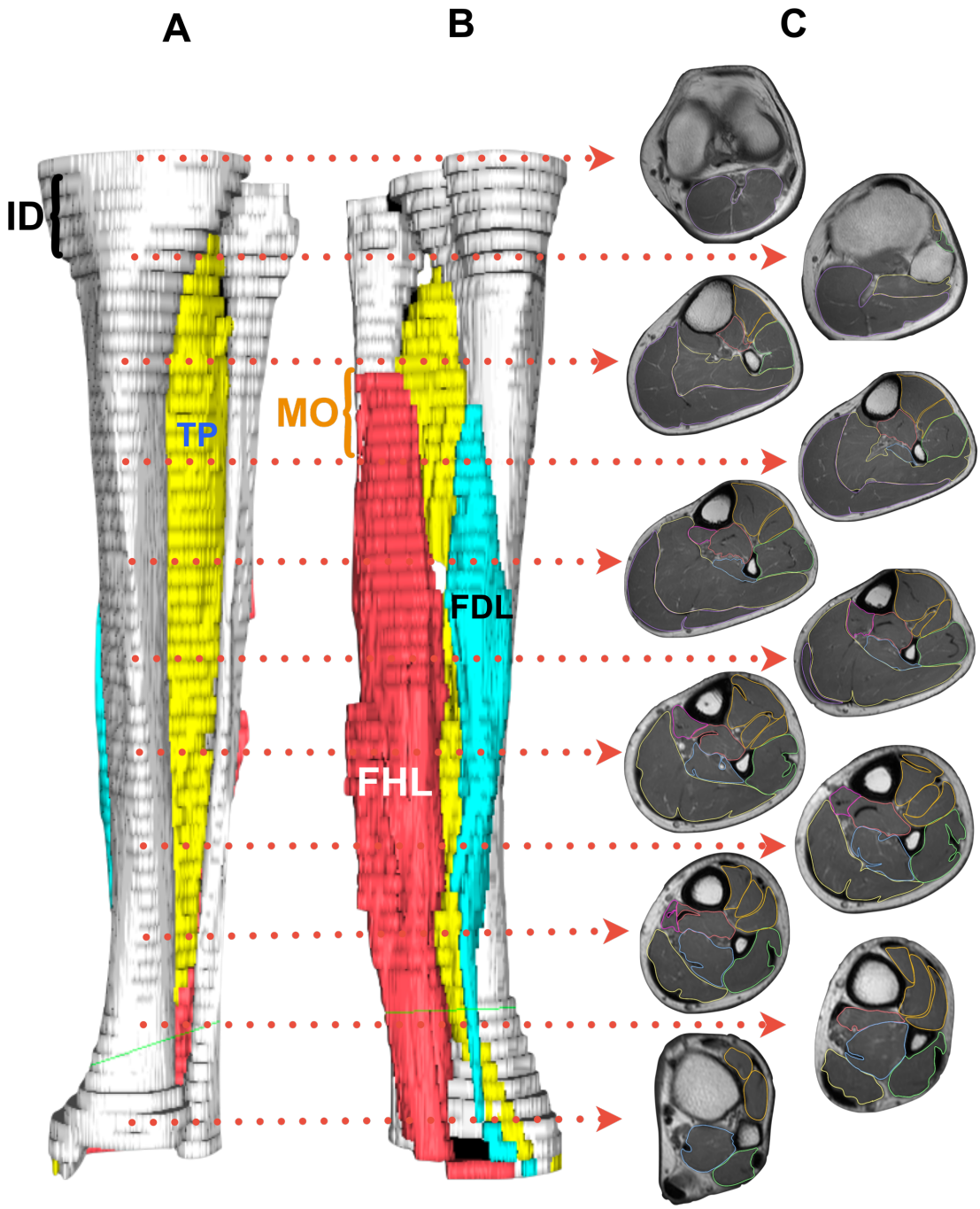

FIGURE 2: 3-D Magnetic Resonance rendered image and corresponding manually segmented slices of a MTSS group participant; **A**, anterior view; **B**, posteromedial view; **C**, Slices Axial cross-sectional areas segmented; **ID**, Inter-slice space of 2.4 cm; **MO**, Muscle origin space [the cone formula was used for inter-slice spaces where there are muscle origins (two subsequently slices, which the first one is without the muscle)]; **FHL**, Flexor hallucis longus; **FDL**, Flexor digitorum longus; **TP**, Tibialis posterior.

Statistical analysis

To best describe the muscles and tendons' structural characteristics, aiming for a more precise comparison between groups, all data were normalized to body mass to the power of 3/4 ($m^{3/4}$). The allometric parameters that relate surfaces (e.g., muscle ACSA) to body mass are closer to 3/4 than to 2/3 in a geometric similarity prediction.(60–62) The categorical variables and the DPC muscles and tendons normalized values were described and analyzed using the IBM SPSS Statistics software, version 29 (IBM Corp. Armonk, NY).

Using the IBM SPSS Statistics software, we applied the Kolmogorov-Smirnov test to access to the presence of parametric distributions. We performed the Levene test to find the homogeneity of variances in the sample. For parametric variables related to the study hypothesis, we created a Multivariate Analysis of Variance model (MANOVA) applying the Pillai's trace for the data considered multivariate parametric data (Henze-Zirkler Test > 0.05) with homogeneity of variance-covariance matrices (Box's M-test > 0.001). We used the t-test for the weight and the body-mass index (BMI). The Intraclass Correlation Coefficient (ICC) was obtained to access inter-rater reliability for all absolute records, and the rater 1 measurements were considered for analysis purposes. The Bland and Altman plot was generated for demonstration of the inter-rater reliability. The Pearson's Chi-Square test was used to determine whether the categorical variables had an influence in MTSS group. Finally, the effect sizes were calculated using as magnitude parameters the values described by Cohen (1988).

4.3 RESULTS

The sample of 30 participants (mean age 32.33 ± 11.35; mean BMI 19.05 ± 3.18) were divided into two groups: MTSS group (n = 18; mean age 30.39 ± 12.415; mean BMI 24.44 ± 3.28), and the Control group (n = 12; mean age 35.25 ± 9.26; mean BMI 25.60 ±3.01). The

sample frequency of men was 53.3% (MTSS = 50%; Control = 58.30%). These characteristics are demonstrated in **table 1.**

TABLE 1: Groups characteristics and sports activity data.

	MTSS	Normal	X^2 (p)
Side (Left)	77.80%	58.30%	-
Gender (male)	50%	58.30%	0.654
Physical activity ##	94.40%	75%	-
Running##	72.20%	25%	0.011
Strength training##	33.33%	33.3%	-
Soccer##	16.70%	0%	-
Swimming##	11.10%	0%	-
Cycling##	11.10%	16.70%	-
Equestrianism##	5.60%	0%	-
Sports court##	5.60%	8.30%	-

MTSS, medial tibial stress syndrome group; Normal, normal group; Physical activity, the practice of any physical activities; Sports court, sports activities practiced indoor (e.g., Basketball, Volleyball); X^2, Pearson's chi-square (p); ##, practice of; *, There were significant differences between groups after post-hoc of Bonferroni ($p<0.01$); -, Did not met Pearson's chi-square minimum criteria.

The ICC (3, k) results showed reliability in the measures of the lower leg DPC (**Figure 3**), superficial posterior compartment (SPC), lateral compartment (LC), and anterior compartment (AC) muscles maximum ACSA, volumes, and tendons maximum ACSA between raters. These ICC results were from 0.886 to 0.999 with significance ($p<0.001$). After the MANOVA model analysis, the DPC showed a superior volume difference of 0.41 $cm^3/kg^{3/4}$ in the MTSS group (Pillai's trace = 0.280; Z (3, 26) = 3.367; p = 0.034). This difference was due to the FHL as shown by the subsequent univariate Analysis of Variance (ANOVA), which demonstrated 0.55 $cm^3/kg^{3/4}$ superior normalized volume in the MTSS group compared to the

control group (F (1, 28) = 5.772; p = 0.023). The model also stated that there was no difference in the volumes of the other DPC muscles (**Figure 4**) (**Table 2).** There was no association of gender with MTSS in our study ($X^2(1) = 0.201$; p = 0.654). The MANOVA model did not demonstrate differences between groups for the normalized volumes of the AC, SPC and LC muscles (Pillai's trace = 0.101; F (6, 23) = 0.433; p = 0.101).

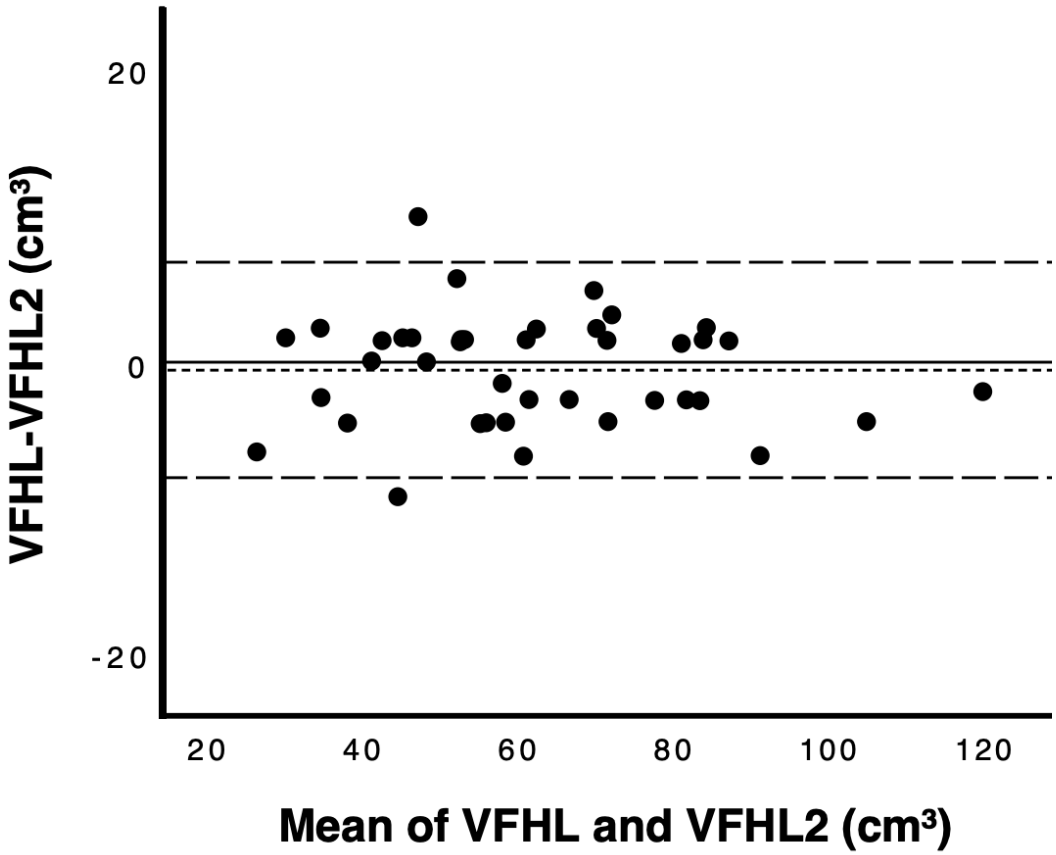

FIGURE 3: Bland and Altman plot of the inter-rater reliability for the Flexor Hallucis Longus Volume. VFHL, first rater measurement of the flexor hallucis longus volume; VFHL2, second rater measurement of the flexor hallucis longus Volume; VFHL-VFHL2, difference from the measures between rater 1 and rater 2; the measurements were similar between raters (p > 0.05); there was not a proportional bias after the regression model test (p > 0.05); dashed lines represent the 95% limits of agreement (LoA).

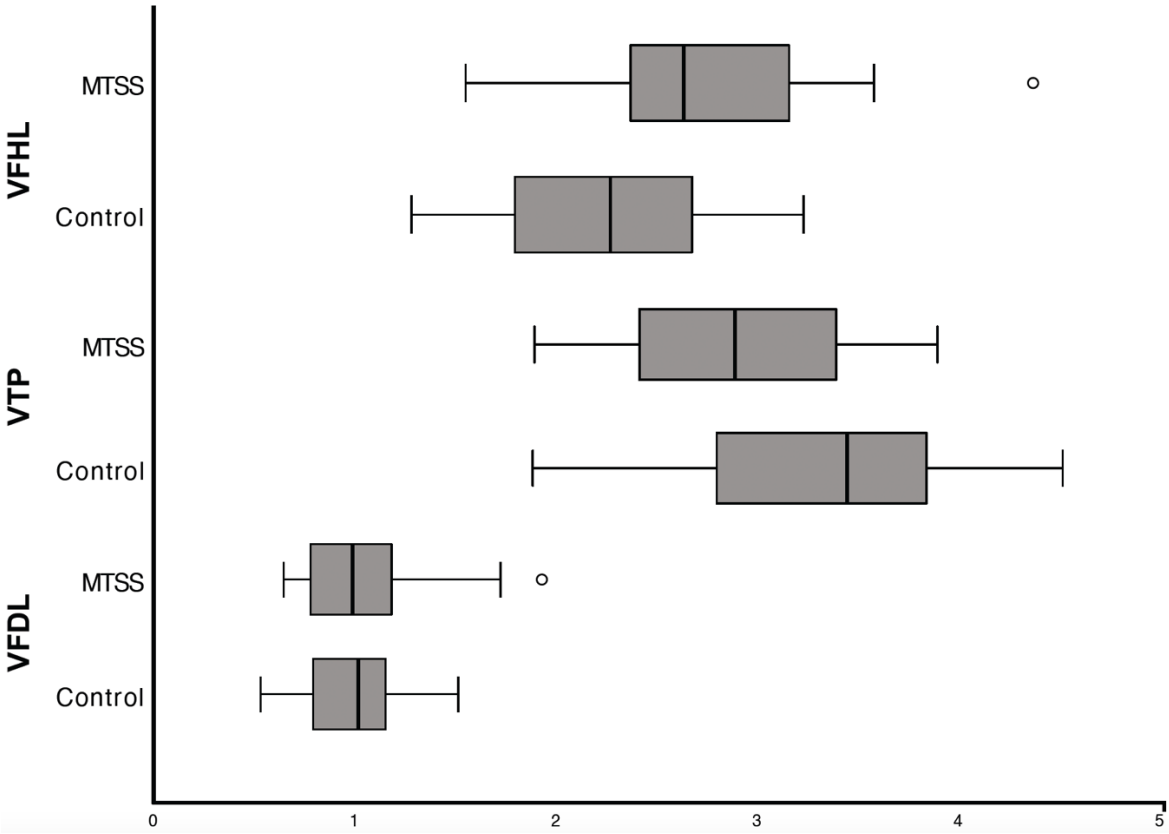

FIGURE 4: Box-plot chart of the normalized deep posterior compartment muscle volumes. V, volume; FHL, Flexor Hallucis Longus; TP, Tibialis Posterior; FDL, Flexor Digitorum Longus; Volume normalization, $cm^3/Kg^{3/4}$; there was significant difference of the normalized FHL volume between MTSS and control groups in the independent t-test and Bonferroni post hoc comparison.

TABLE 2: MANOVA model and t-tests results for the lower leg muscles morphometric data. Comparisons between MTSS and Control groups.

		MTSS value	Control value	Kolmogorov-Smirnov (p)	Levene (p)	(p)	Cohen-d	Effect sizes
MANOVA	TP Volume Normalized	3.15	3.38	0.200	0.923	0.461	-0.278	Small
	FDL Volume Normalized	1.08	0.98	0.200	0.967	0.463	0.277	Small
	FHL Volume Normalized	2.76	2.21	0.200	0.922	0.023*	0.895	Large
INDEPENDET T-TEST	Weight (kg)	72.56	75.96	0.200	0.346	0.249	-0.987	Large
	BMI	24.44	25.59	0.200	0.415	0.440	-1.097	Large
	FDL muscle Maximum ACSA Normalized	0.82	0.79	0.200	0.174	0.289	0.178	Small
	FHL muscle Maximum ACSA Normalized	0.19	0.17	0.200	0.529	0.085	0.525	Medium
	TP tendon Maximum ACSA Normalized	0.20	0.19	0.200	0.938	0.405	-0.076	Small
	FHL tendon Maximum ACSA Normalized	0.0045	0.0040	0.200	0.087	0.059	0.389	Small

Abbreviations and symbols: TP, Tibialis Posterior; FDL, Flexor Digitorum Longus; FHL, Flexor Hallucis Longus; ACSA, axial cross-sectional area; ACSA normalization, $mm^2/Kg^{3/4}$; volume normalization, $cm^3/Kg^{3/4}$; MTSS value and Control value, MTSS and control groups values in $mm^2/Kg^{3/4}$; *, There was significant difference of the normalized FHL volume between MTSS and control groups in the ANOVA subsequent model after the MANOVA.

4.4 Discussion

Our results showed a superior normalized volume of the DPC due to the FHL muscle volume, and the current literature has described the DPC muscles as a possible origin of the tenting effect, which is a possible cause of MTSS. We suggest this increased volume should not directly impact the PTB, as this muscle does not share any origins with the tibia. Instead, it should directly impact the transverse intermuscular septum, which is conjoined with the tibial fascia in the PTB, thus creating the tenting effect.(63) Nevertheless, Saeki et al. (2017) proposed a different hypothesis, stating that there is no relation between the FHL and the tibial fascia. Instead, they suggested that there is a possible increased action of the FHL to reduce load to the flexor digitorum longus, thereby avoiding pain caused by contraction stress of the FDL.(21) Bouché and Johnson (2007) proposed a pathomechanical model involving fascial traction of the PTB.(1) They believed the anatomical, pathologic, diagnostics, and clinical findings were consistent with the MTSS origin and described that the tibial fascia is inserted along all the tibia medial crest length, and there was no other anatomical structure related to it. Furthermore, they denoted that there are many cases of MTSS where patients declare having pain along the entire PTB, and theorized an increased tibial fascia tension is due to the eccentric contraction of the superficial and deep flexor tendons of the leg, and first proposed the denomination “tenting effect”.(1)

It was previously cited the increased eccentric contractions of the deep flexors is present for shock dissipation when there is excessively pronation environment.(64) Several studies demonstrated an excessive pronation and a positive navicular drop test in runners with MTSS, with these being risk factors for stress-related injuries.(12–14,16) Other studies theorized the relationship of the DPC muscles with excessive pronation and MTSS.(1,21,64) In this context, Saeki et al. (2017) suggested that athletes with a history of MTSS could adopt a medial tibia

load-reducing strategy. They described in a strength measurement study using an electric dynamometer that there is increased strength in DPC.(21) Further prospective biomechanical studies should discuss these possibilities to conclude the causality effect of DPC muscles in MTSS, since the FHL demonstrates a superior volume.

Multiple systematic reviews evaluate the effectiveness of lower extremity injury prevention programs based on physical exercises and strength training of the leg muscles; these exercises overwhelmingly reduce the chance of developing lesions in the lower limb.(65) Moreover, muscular fatigue is the core of one of the most studied hypotheses on the aetiology and etiopathology of MTSS.(16) Nevertheless, several studies reported the anatomical findings of the lower leg muscle origins. They refuted the traction theory (tenting effect), as they expressed the absence of direct muscle insertions on the distal two-thirds of the PTB.(53,66,67) As we discussed, the structure directly related to all PTB length is the tibial fascia.(20) It is not possible to rule out the tenting effect theory based only on anatomical muscle direct insertion and origin.

Although the current literature suggests that the majority of individuals affected by MTSS are females our study did not find a significant association between gender and MTSS.(12–14,16,50) There were more men in our sample, though, with a superior percentage in the Control group. Also, a history of lower limb musculoskeletal injuries is considered a risk factor for MTSS.(49) However, our study design excluded individuals with previous limb injuries, once it could affect the morphometric parameters of muscles, ligaments, and tendons.(68) This could have led to a potential source of bias in the measurements, but after excluding previous injuries, we expected more homogenous groups with less significant differences.

Another factor that would lead to less differences between groups is the convenience selection of the control participants. We selected patients with normal MRI exams of the lower leg; however, a high percentage of them had experienced pain in the PTB. This is due to the

study's retrospective design, in which patients had a clinical indication for the MRI exam. To avoid biases, we also excluded control group individuals who experienced pain in the PTB and MTSS group individuals who had not experienced pain in the PTB. In addition, there was a difference in the FHL, with MTSS participants showing higher muscle volume. The tendency for homogeneity between groups, caused by the possibility of control individuals being also affected by the syndrome clinically, reinforces the statistical value of the differences found.

The other DPC and SPC muscles did not show alterations in their measurements. We cannot conclude these differences does not exist due to the selection of the control group. Despite these, some studies did not find the relations of the SPC muscles as causes of MTSS, which can corroborate our SPC results as being morphometric homogeneous between groups.(13,69) Also, the TP and the FDL had no strength difference in a biomechanical study.(21)

The limitations of this study are mainly due to the retrospective cross-sectional design, in which we cannot establish causality effect, but only associations between variables and groups. For example, we could not describe with precision the pain characteristics besides the location and the level of physical activities practice because the pre-exam questionnaire did not leave these options for the patients to fill. Also, the sample size could not state the inexistence of differences for the other DPC muscle. Still, the sample size was sufficient to express the difference in the FHL muscle volume with the magnitude described.

We attempted to improve scientific knowledge about the morphometric aspects of individuals with MTSS. To our knowledge, there are no studies in the present literature describe the morphometric parameters of individuals with MTSS in MRI exams. The physiological aspects behind the response to and the prevention of MTSS have still not been entirely established.(70) Further studies with prospective design should be encouraged to describe more details of the DPC muscles and their relations to MTSS.

4.5 Conclusion

This report investigated the morphometric aspects of the deep posterior compartment of the lower leg, which is suggested as a possible tenting effect origin. There was a superior FHL muscle volume normalized by the body mass in patients presenting MTSS. Our sample did not show an association between gender and MTSS.

4.6 Clinical relevance

The excessively foot pronation environment was previously cited as probable cause of the tenting effect in the posteromedial tibial border, and there is an increased flexor hallucis longus volume in individuals with MTSS as evidence of the tenting effect. Clinicians should encourage patients to avoid activities where the excessively foot pronation could happen when the MTSS diagnosis is confirmed.

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5.0 REGRAS DE SUBMISSÃO

Journal: SPORTS HEALTH
Qualis 2017-2020: Medicina III: A1
Fator de impacto JCR 5 ANOS: 5.2

1. Submissions

Manuscripts should be submitted electronically to the *Sports Health* submission site. Submissions that have been started but not fully submitted will be deleted 10 days after submission creation.

Manuscripts must not be under simultaneous consideration by any other publication, before or during the peer-review process, and cannot be uploaded to any preprint server.

Authors must include an exclusive license agreement (copyright) form and ICMJE Disclosure form with their submission. The forms can be uploaded with the manuscript or emailed to the *Sports Health* editorial office. All conflicts of interest must be provided with an individual ICMJE Disclosure form for each author. When making a declaration, the disclosure information must be specific and include any financial relationship that all authors of the article has with any sponsoring organization and the for-profit interests the organization represents, and with any for-profit product discussed or implied in the text of the article. Any commercial or financial involvements that might represent an appearance of a conflict of interest need to be additionally disclosed in the cover letter accompanying your article to assist the Editor-in-Chief in evaluating whether sufficient disclosure has been made.

With exclusive license, authors in *Sports Health* are allowed to (1) post their *original* manuscript online immediately with no permission needed; (2) post on any noncommercial repository or website the accepted/peer-review version online 12 months after print publication; (3) distribute a not-for-profit basis photocopies of the published Contribution for teaching purposes or to research colleagues; (4) and republish the whole or any part of their work without permission as long as they cite the original source 12 months after print publication. Articles, tables, and figures that have been published in *Sports Health* may not be published elsewhere by anyone other than the authors without written permission from the

exclusive license holder. Authors are responsible for ordering reprints of their articles, which can be done by contacting reprint@sagepub.com.

Please make sure prior to submission that all author names are spelled correctly and consistent with authors' other publications. This will ensure that articles will index correctly in PubMed. We are unable to make changes for author order/name inconsistency after final proofs are reviewed and accepted.

Ethics Policies

All papers reporting animal and human studies must include whether written consent was obtained from the local Ethics Committee or Institutional Review Board. Please ensure that you have provided the full name and institution of the review committee and an Ethics Committee reference number.

We accept manuscripts that report human and/or animal studies for publication only if it is made clear that investigations were carried out to a high ethical standard. Studies in humans that might be interpreted as experimental (eg, controlled trials) should conform to the Declaration of Helsinki, and manuscripts must include a statement that the research protocol was approved by the appropriate ethical committee. **Registration of clinical trials in an appropriate repository (http://clinicaltrials.gov or other suitable databases identified by the ICMJE) is required for all trials starting after January 1, 2019. Submissions of clinical trials should include the registration number and name of the trial register.**

As of June 15, 2021, submissions must include IRB/ethics approval letters be submitted before review. These must be copies of the original approval documents. Please upload documentation of approval as a legal document to the copyright area.

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Patient Consent

Authors are required to ensure the following guidelines are followed, as recommended by the International Committee of Medical Journal Editors, Uniform Requirements for Manuscripts Submitted to Biomedical Journals. Patients have a right to privacy that should not be infringed without informed consent. Identifying information, including patients' names, initials, or

hospital numbers, should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives written informed consent for publication.

Identifying details should be omitted if they are not essential. Complete anonymity is difficult to achieve, however, and informed consent should be obtained if there is any doubt. When informed consent has been obtained it should be indicated in the submitted article. Download an audio-visual likeness release here.

Manuscript Formats

Manuscript pages should be typed double-spaced with the pages and lines numbered. Generally, manuscripts should be 4,500 words or less (see below for guidelines specific to video tutorials and case reports). Manuscripts will be converted to a PDF file that reviewers download. It is important that NO identifying material is in the submitted manuscript.

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Manuscript Preparation

Abstract

An abstract that summarizes the content of the article in <300 words is required for a manuscript submission. Please include the abstract in the manuscript text file when it is uploaded. Please include 3-5 keywords at the end of all abstracts.

Abstracts for **Systematic Reviews and Meta-analyses** should include the headings context, objective, data sources, study selection, study design, level of evidence, data extraction, results, and conclusions.

Example: A method for systematically combining pertinent qualitative and quantitative study data from several selected studies to develop a single conclusion that has greater statistical power. This conclusion is statistically stronger than the analysis of any single study, due to increased numbers of subjects, greater diversity among subjects, or accumulated effects and results.

Abstracts for **Clinical Reviews** should include the headings context, evidence acquisition, study design, level of evidence, results, conclusions, and Strength-of-Recommendation Taxonomy (SORT) (see **Section 4.5** for more information).

Example: A way to provide a clear, up-to-date account of the topic. The review should include a broad update of recent developments (from the past 1-2 years) and their likely clinical applications in primary and secondary care. The article should also try to highlight the bridge between primary and secondary care and offer specific information on what general practitioners should know about the condition.

Abstracts for **Clinical Research** should include the headings background, hypothesis, study design, level of evidence, methods, results, conclusions, and clinical relevance.

Example: A scientific study of how a new medicine or treatment works in people. Through clinical studies, doctors find new and better ways to prevent, detect, diagnose, control, and treat illnesses.

Level of Evidence should be based on this scale.

Abstracts for **Case Reports, Infographics, and Video Tutorials** may be unstructured, but should be sufficiently detailed to summarize work and its importance.

Example: An article that describes and interprets an individual case, often written in the form of a detailed story.

Abstracts for **Translational and Basic Science Research** should follow the same format described for *Clinical Research* abstract guidelines above.

Text

Maximum recommended text length is usually 8 pages, or 4,500 words. *Sports Health* follows the American Medical Association (AMA) Manual of Style. Use generic names of drugs. If a particular brand was used in a study, insert the brand name along with the name and location of the manufacturer in parentheses after the generic name. The name and location of equipment manufacturers also should be included in parentheses behind the name of the product.

Units of measure following a number are abbreviated (such as kg, cm). Use metric units in measurements (that is, centimeter vs inch, kilogram vs pound). Limit use of abbreviations; abbreviated terms not used >3 times should be spelled out. When uncommon abbreviations are used, give the full term followed by the abbreviation in parentheses the first time it is mentioned in the text, such as femur-ACL-tibia complex (FATC).

Reports on surgery, except in rare instances, require a minimum follow-up of two years.

P values should be reported in 3 digits, such as 0.05, < 0.01, 0.25, etc. *P* values reported differently will be edited to this format.

Any material that is submitted with an article (eg, tables and figures) that has been reproduced in another source must conform to the current copyright regulations. It is the author's responsibility to obtain written permission for reproduction of copyrighted material and to provide that documentation to the editorial office before publication. Download a permission form here.

The author is responsible for all statements made in the work, including copy editor changes.

Article Types

Sports Health publishes Guest Editorials, Letters to the Editor, Author's Response, Systematic Reviews or Meta-analysis, Clinical Reviews, Clinical Research, Case Report, Video Tutorial, and Infographics. For an in-depth definition of each article types, please click here.

If there are specific requriements for submission types, they are outlines below.

4.3.1 Systematic Reviews

Submissions should include a Systematic Review Checklist with other submission requirements. This form can be accessed here.

4.3.2 Clinical Research

At the end of each Clinical Research paper, Clinical Recommendations should be included. These will be highlighted for the reader. The Strength-of-Recommendation Taxonomy (SORT) is required for all clinical recommendations (see below). Use SORT

to trate the recommendation based on the strength of the scientific or clinical evidence available to support it. SORT is required for all clinical recommendations. (*American Family Physician,* July 1, 2006; Vol 74, Number 1.)

4.3.3 Infographics

An infographic is a clear and concise pictorial representation of research, technology, or technique. All Infographics should include an abstract, infographic file and references. Infographics submitted for peer-review may take one of two formats:

1. **Standalone Infographics.** If the infographic presents a complete and scientifically robust visual of a message, it may be published alone without accompanying text.
2. **Supplemented Infographic.** If the infographic visual requires support for the message, it should be accompanied by a short clinical or research review presented in our standard journal format.

4.3.4 Video Tutorials

Video tutorials should be submitted using the below guidelines. These articles are meant to be visual synopses of current physical tests, rehabilitation maneuvers, surgical techniques, etc. Text is limited to 1,500 words, with an unstructured abstract (250 words, followed by 3-5 MeSH keywords) and maximum of 8 references. Tables should be used sparingly, and there is unlimited use of figures; however, figures should be restricted to only those images that cannot be shown clearly within the video file. Please be sure that all figures include a legend that describes what is being shown.

The video files should be supplied as an MPEG (preferred), Apple QuickTime, or Microsoft Audio/Video Interlaced file and as small as possible without affecting quality for optimal streaming per best-practice guidelines (please utilize file -reducing software if possible). Videos should be of professional quality, and narration is expected. Subjects should be in focus, and all exam maneuvers should be clearly seen by the viewer. Please be careful with the background (including images, devices, and lighting); plain, light colors work best.

Any individual shown within the video will need to provide a signed **visual likeness release** prior to publication. We cannot "black out" any individuals or body parts from video files. Anyone from whom you cannot obtain release should not be included.

*If you believe that the subject matter that you'd like to present cannot be sufficiently presented within these guidelines, please contact Ed Wojtys, Editor-in-Chief, at ewojtys@sportshealthjournal.org.

4.3.5 Case Reports

Case reports should have no more than 1,200 words, inclusive of the abtract, text, any relevant figure legends, and references. Abstracts should be unstructured. Case reports should not include tables but rather relevant figures with legends describing what is being shown. If anything provided within the case report (images or text) makes the patient identifiable, then you must include a statement confirming that permission was granted by the patient, family, or parent/guardian to publish the case report.

4.4 Authorship and Acknowledgment

Submission of a manuscript implies that all authors have contributed substantially to the work and know and approve the content of the submitted manuscript. Please refer to the ICMJE Authorship guidelines. Our policy discourages the inclusion of >7 authors on an article. If >7 authors are listed, the contribution of each author to the work should be explained in the cover letter. Any person who contributed to the work but does not qualify for authorship should be included in the "Acknowledgments" section. Type acknowledgments in the box provided on the submission page. Please briefly describe the contributions made by acknowledged persons.

4.5 References

References should be typed double-spaced in alphabetical order and numbered according to the alphabetical listing. If references are not in alphabetical order, the uploaded file will be returned to the corresponding author for correction and resubmission in the correct form. When author entries are the same, alphabetize by the first word of the title. In general, use the Index Medicus form for abbreviating journal titles and the *AMA Manual of Style* for format.

References must be retrievable. Do not include in the reference list presentations from meetings that have not been published. Data such as presentations and articles that have been submitted for publication but have not been accepted must be put in the text as unpublished data immediately after mention of the information (for example, "Smith and Jones (unpublished data, 2000) noted in their study ...").

4.6 Tables

For tables, the system accepts most common word processing formats, but Word and PDF are preferred. Tables should be included at the end of the manuscript text file so that they are included in the PDF used by reviewers. Tables should be numbered consecutively and have a title. Please be sure the title describes the content and purpose of the table. Tables should enhance, not duplicate, information in the text. Simple tables that repeat textual material will be deleted. It is the author's responsibility to submit permission to reproduce any tables that have been published previously. Download a permission form here.

4.7 Figures and Illustrations

Figures for papers accepted for publication must meet the requirements of the publisher, Sage Publications. Files for line drawings should be created at 1200 dpi, for color photographs at 600 dpi, and for black and white photographs at 300 dpi. Please remember that many image formats are *not* acceptable for reproduction. Please ensure the quality of your figures match the guidelines provided.

Figures should be submitted in the original form created. Images embedded in Word or PowerPoint files are not acceptable. Glossy prints can be sent to the journal once the paper is accepted if you cannot meet the digital art requirements for publication. Color images are preferred for photographs and bar graphs/charts. Be sure all symbols or arrows are described in the legend. If figure parts (such as A, B) are provided, the legend must explain each part of the figure. Terms used for labels and in the legend must be consistent with those in the text.

Examine all figures carefully to ensure that the data are presented with the greatest possible clarity. Likewise, determine if a figure would communicate the information more effectively than lengthy narrative. It is the author's responsibility to obtain and submit signed permission to reproduce any copyrighted figures that have been published previously. Download a permission form here.

In order to perform double-anonymized peer-review, all identifying features within photographs must be remmoved. Participant faces should be occluded and logo should be blurred. For publication, identifiable subjects must sign the audio-visual likeness release form.

The backgrounds of photographs should be as simple and free of distractions as possible. Authors may be asked to provide new images if the photos have “busy backgrounds.”

If an identifier is needed on an image with multiple parts (eg, a, b, c), please provide the image with a lowercase letter without using parentheses on the bottom right corner in size 10 pt font. Identifiers are only used when there is a grouped legend. If the image can be presented by itself with its own ledgend no identifier is needed on the image. In addition, any other text used on the image (including arrows, asterisks, etc) should be provided in a separate layer from the base image.

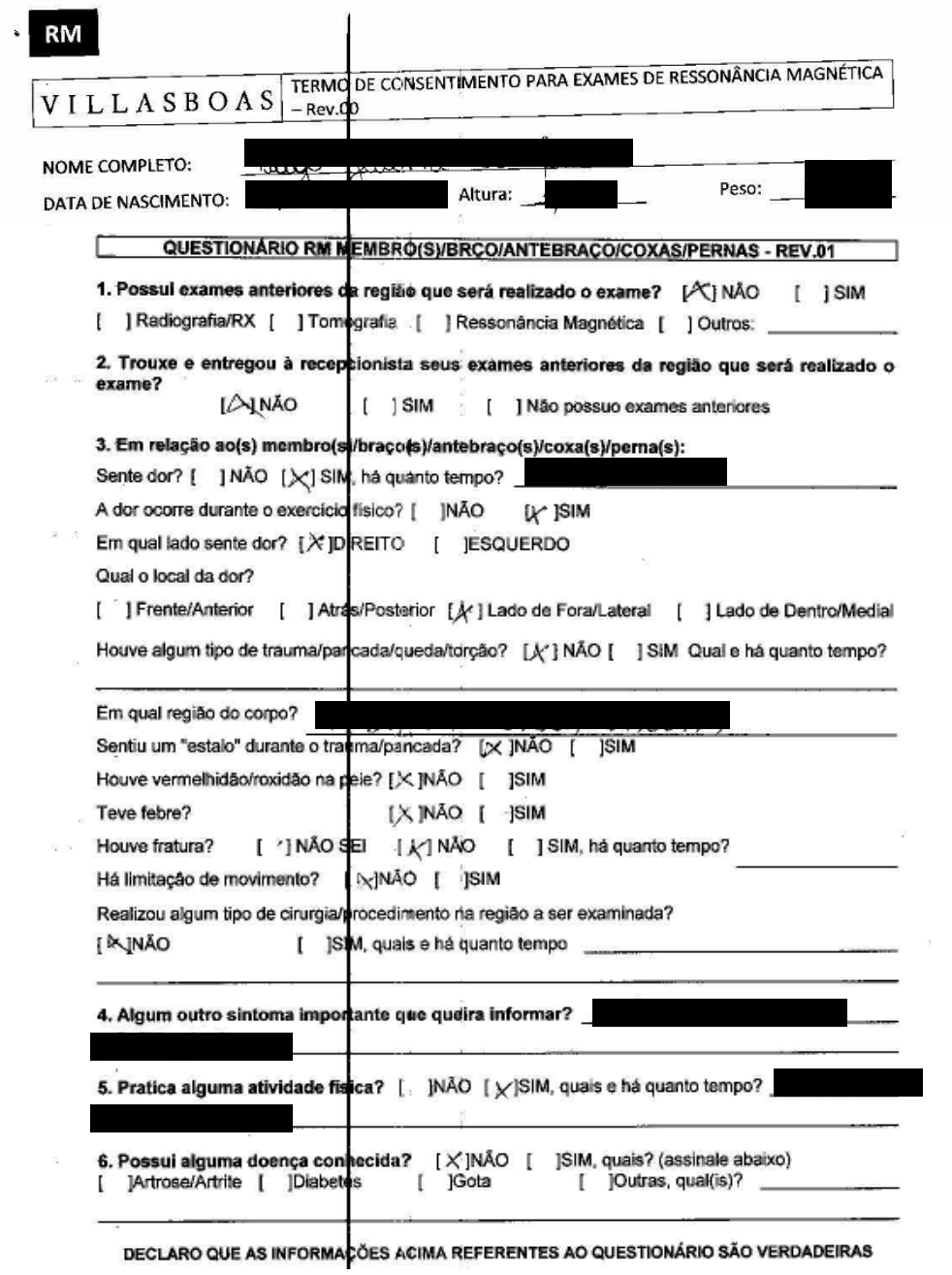
Charts/graphs should have axes labeled using title capitalization (eg, Mean Follow-up for Athletes). In addition, units should be provided for all axes when necessary and set aside from the table in parentheses.

4.8 Videos

Videos may be submitted with a manuscript to be posted online. Please see the Video Format Guide for format requirements. For copyright/permissions information, view the Video Permission and Fair Use Quick Guide. Identifiable subjects in video will need to sign the Audio-Visual Likeness Release form. It is the author's responsibility to submit forms for each video.

ANEXOS

Exemplo de questionário aplicado anteriormente aos exames de Ressonância Magnética.



RM

VILLASBOAS | TERMO DE CONSENTIMENTO PARA EXAMES DE RESSONÂNCIA MAGNÉTICA – Rev.00

NOME COMPLETO: [redacted]

DATA DE NASCIMENTO: [redacted] Altura: [redacted] Peso: [redacted]

QUESTIONÁRIO RM MEMBRO(S)/BRÇO/ANTEBRAÇO/COXAS/PERNAS - REV.01

1. Possui exames anteriores da região que será realizado o exame? [X] NÃO [ ] SIM

[ ] Radiografia/RX [ ] Tomografia [ ] Ressonância Magnética [ ] Outros: _____

2. Trouxe e entregou à recepcionista seus exames anteriores da região que será realizado o exame?

[X] NÃO [ ] SIM [ ] Não possuo exames anteriores

3. Em relação ao(s) membro(s)/braço(s)/antebraço(s)/coxa(s)/perna(s):

Sente dor? [ ] NÃO [X] SIM, há quanto tempo? [redacted]

A dor ocorre durante o exercício físico? [ ]NÃO [X]SIM

Em qual lado sente dor? [X]DIREITO [ ]ESQUERDO

Qual o local da dor?

[ ] Frente/Anterior [ ] Atrás/Posterior [X] Lado de Fora/Lateral [ ] Lado de Dentro/Medial

Houve algum tipo de trauma/pancada/queda/torção? [X] NÃO [ ] SIM Qual e há quanto tempo?

Em qual região do corpo? [redacted]

Sentiu um "estalo" durante o trauma/pancada? [X]NÃO [ ]SIM

Houve vermelhidão/roxidão na pele? [X]NÃO [ ]SIM

Teve febre? [X]NÃO [ ]SIM

Houve fratura? [ ] NÃO SEI [X] NÃO [ ] SIM, há quanto tempo?

Há limitação de movimento? [X]NÃO [ ]SIM

Realizou algum tipo de cirurgia/procedimento na região a ser examinada?

[X]NÃO [ ]SIM, quais e há quanto tempo

4. Algum outro sintoma importante que queira informar? [redacted]

5. Pratica alguma atividade física? [ ]NÃO [X]SIM, quais e há quanto tempo? [redacted]

6. Possui alguma doença conhecida? [X]NÃO [ ]SIM, quais? (assinale abaixo)

[ ]Artrose/Artrite [ ]Diabetes [ ]Gota [ ]Outras, qual(is)?

DECLARO QUE AS INFORMAÇÕES ACIMA REFERENTES AO QUESTIONÁRIO SÃO VERDADEIRAS