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Journal of Manual & Manipulative Therapy

ISSN: 1066-9817 (Print) 2042-6186 (Online) Journal homepage: http://www.tandfonline.com/loi/yjmt20

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To cite this article: Lindsay Carlton, Joseph R. Maccio, Joseph G. Maccio, Andrew Braga, Elizabeth Tomanio & Anastasia Belikov (2018): The application of Mechanical Diagnosis and Therapy to the ankle-foot complex: a case series, Journal of Manual & Manipulative Therapy, DOI: 10.1080/10669817.2018.1456028

To link to this article: https://doi.org/10.1080/10669817.2018.1456028

Published online: 29 Mar 2018.

JOURNAL OF MANUAL & MANIPULATIVE THERAPY, 2018
https://doi.org/10.1080/10669817.2018.1456028

The application of Mechanical Diagnosis and Therapy to the ankle-foot complex: a case series

Lindsay Carlton, Joseph R. Maccio, Joseph G. Maccio, Andrew Braga, Elizabeth Tomanio and Anastasia Belikov

Maccio Physical Therapy, Troy, NY, USA

ABSTRACT

Background: Pain at the ankle-foot complex is a common musculoskeletal condition that can lead to dysfunction. Mechanical Diagnosis and Therapy (MDT) is an orthopedic classification and treatment system based on mechanical and symptomatic response to repeated and sustained movement. There has been no investigation of the association between MDT and patients diagnosed with ankle-foot complex pain.

Case description: This report presents four patients with a primary complaint of pain in the ankle-foot complex. Three patients had a medical diagnosis while the other was self-referred through direct access. All received classification and treatment by clinicians trained in MDT solely utilizing MDT principles.

Outcomes: Short- and long-term (4–12 months) outcomes were excellent, demonstrating rapid abolishment of symptoms and return to prior levels of function in an average of six visits over 21 days (4–8 visits over 14–33 days) without the use of modalities, strength, or proprioceptive training. The patients demonstrated the ability to prevent and manage re-occurrence of symptoms independently without seeking further health care at long-term follow-up.

Discussion: The rapid speed of recovery and return to functional activities demonstrated in this case series, raises questions about whether or not the pathologies traditionally associated with the etiology of ankle-foot injuries are actually at fault or understood. Moreover, it demonstrates that specific movements can rapidly worsen or improve symptoms challenging the current generalized rehabilitation protocols. This report provides preliminary evidence that MDT may be capable of providing more effective short-term outcomes in the management of ankle-foot complex injuries. **Level of Evidence:** 4.

KEYWORDS
Mechanical Diagnosis and Therapy; McKenzie; classification; ankle sprain; derangement; lumbar spine; posterior tibialis tendonitis; plantar fasciitis

Background

A systematic review of a combined 75,505 participants reported a pooled population prevalence estimate of 24% would experience frequent foot pain and 15% would experience frequent ankle pain [1]. Current clinical practice guidelines are patho-anatomical in nature, and therefore treatment and prognosis is also based as such [2]. An alternate evaluative method, Mechanical Diagnosis and Therapy (MDT), assesses for mechanical changes of a joint as it relates to functional deficits. Doing so in the extremities has demonstrated rapid results in the shoulder, temporomandibular, knee, ankle, wrist, and elbow joints [3–12].

The utility of patho-anatomical assessment in the lumbar spine and extremity has been shown to be unreliable [13,14] and poorly understood, as demonstrated in recent MDT literature [4,6,9,11,14,15]. Non-specific classification-based assessment and treatment systems, such as MDT, have demonstrated acceptable levels of reliability in the management of patients with spinal and extremity impairments [16,17].

At this time, there is no publication reporting on the management of acute/subacute pain in the ankle-foot complex using MDT. The aim of this case series was to demonstrate MDT evaluation, classification, and management of four patients with acute/subacute pain in the ankle-foot complex.

Methods

Four patients with primary complaints of ankle-foot pain were evaluated in an outpatient certified McKenzie Spine and Extremity Clinic by MDT-trained clinicians. The lead examiner (JRM) holds a doctorate in physical therapy and a diploma in MDT and was the treating clinician in Case 1 and 4. A second clinician (JGM) provided the treatment in Case 2 and holds a master's degree in ergonomics, a bachelor's in physical therapy, and a diploma in MDT. The final treating clinician (AB), treated Case 3 and holds a doctorate in physical therapy and has completed MDT introductory courses for the lumbar (Part A) and cervical (Part B) spine.

CONTACT Lindsay Carlton lindsaycarlton15@gmail.com

MDT assessment involved the use of repetitive and sustained movements while monitoring symptomatic (e.g. pain) and mechanical responses (e.g. strength, range of motion, and functional movements) to classify musculoskeletal disorders into the following syndromes: derangement, dysfunction, postural, and other (Table 1) [18]. No other treatment modalities or therapies were performed other than those reported in the case descriptions.

The primary outcome measures for this study were the Numeric Pain Rating System (NPRS) and Lower Extremity Functional Scale (LEFS). These are previously validated measures for assessing pain and function with established minimally detectable change (MDC) values [19–21]. As advocated by McKenzie and May range of motion measurements was categorized using nil, minimal, moderate, and major loss [18]. Reproduction of ankle-foot pain during functional activity (e.g. standing, squatting, walking, running, jumping, etc.) was recorded pre- and post-physical examination and is referred to as a baseline or concordant sign.

Case 1

Patient characteristics

A 49-year-old female presented with intermittent right lateral ankle pain affecting 76–100% of her day. There was no pain at rest. The patient's symptoms commenced 14 days prior after landing incorrectly during an exercise movement. The patient reported resting her ankle and avoiding painful activities; however, symptoms had not improved. Symptoms were reported worse with weight bearing, descending stairs, and sitting cross-legged with the affected foot in plantar flexion. The patient was no longer able perform any exercise involving jumping or running, including train for a half marathon. Her LEFS score was 44/80, indicating 55% of complete function. She was self-referred with no medical diagnosis and no co-morbidities. Average NPRS of 6/10; ranging from 4/10 to 8/10. She denied having any previous treatment or use of pain medication.

Examination and clinical impression

Lateral ankle pain was produced by passive ankle inversion and jumping. There was minimal loss of ankle dorsiflexion and plantar flexion, and moderate loss of inversion with sharp end-range pain eliciting audible distress from the patient. Manual muscle testing found all ankle strength to be within normal limits, except eversion which was weak and painful.

Repeated loaded dorsiflexion (Figure 1(a)) was tested resulting in increase in dorsiflexion to minimal-nil loss, which was enough to suspect joint derangement. Repeated loaded plantar flexion caused significantly more pain during the entire movement and had no effect on mechanical or symptomatic baselines. Since sagittal movement was tested with no positive effect on symptomatic baselines, the treating clinician decided lateral forces should be explored. Based on symptom location and mechanism of injury, a more compressive force to the lateral aspect of the affected ankle was tested using loaded dorsiflexion with eversion (Figure 1(b)). This resulted in significant reduction [22] in painful baselines suggesting the pain was not driven from an inflammatory state, fracture, or structurally compromised tissue. This presentation fits the provisional classification of ankle derangement, with a directional preference of loaded dorsiflexion in eversion. The patient was instructed to perform 10 repetitions of loaded dorsiflexion in eversion every 2 h.

Intervention, follow up, and outcome

On visit 3, the patient plateaued at 50% improvement, warranting reassessment. Her remaining complaint was pain with active inversion. Repeated loaded dorsiflexion (Figure 1(a)) abolished this symptom, confirming a new directional preference. Retesting of loaded dorsiflexion with eversion (Figure 1(b)), caused pain with inversion once again, which then abolished following loaded dorsiflexion (Figure 1(a)).

This presentation confirms the classification of ankle derangement, with a new directional preference of loaded dorsiflexion. The patient was instructed to perform 10 repetitions of loaded dorsiflexion every 2 h and to return to running and all plyometric cross-training without restriction. She was discharged from supervised therapy the next visit and instructed to continue loaded dorsiflexion for one month, approximately, three times daily. The patient was seen for four visits over 14 days with abolishment of symptoms and ability to self-reduce any recurrences.

At 1-, 6-, and 12-month in-person or phone interview follow-ups she reported no re-occurrence of symptoms or functional deficit, except for one instance of landing from a high jump one month after discharge. Symptoms did not linger or cause functional deficit. The patient was able to continue high-level athletic training and completed a marathon run with no associated symptoms.

Case 2

Patient characteristic

A 77-year-old female referred to physical therapy by her rheumatologist for the medical diagnosis of posterior tibialis tendonitis. Left medial ankle pain was intermittent, affecting 75–100% of her day. The patient's symptoms commenced 4 weeks prior for no apparent reason and had been unchanging since onset. Symptoms were reported worse with walking on treadmill, standing, stair negotiation, and morning hours. LEFS score was 38/80,

Table 1. MDT syndromes.

Classification	Definition	Treatment strategy
Derangement	• An internal dislocation of articular tissue of unknown origin which causes a disturbance in the normal resting position of the affected joint surface, resulting in pain and obstruction to movement	• Repeated movement in one direction, known as directional preference • Directional preference is associated with improvement in symptoms, and/or mechanical presentation (i.e. range of motion, strength, etc.)
Dysfunction	• Mechanical deformation of structurally impaired soft tissue which results in pain and limited range of motion • Subcategorized into articular dysfunction and contractile dysfunction	• Progressive tissue loading to remodel the articular or contractile tissue
Postural syndrome	• Mechanical deformation of normal soft tissues or vascular insufficiency arising from prolonged positional stresses resulting in pain	• Patient education and avoidance of the offensive position
Other	• Pain or condition of non-mechanical origin • Examples of these conditions include, but are not limited to, cancer, fracture, vascular pathology, chronic pain syndrome, trauma, soft tissue pathology, post-surgical, and inflammatory conditions	• Referral to appropriate physician or specialist

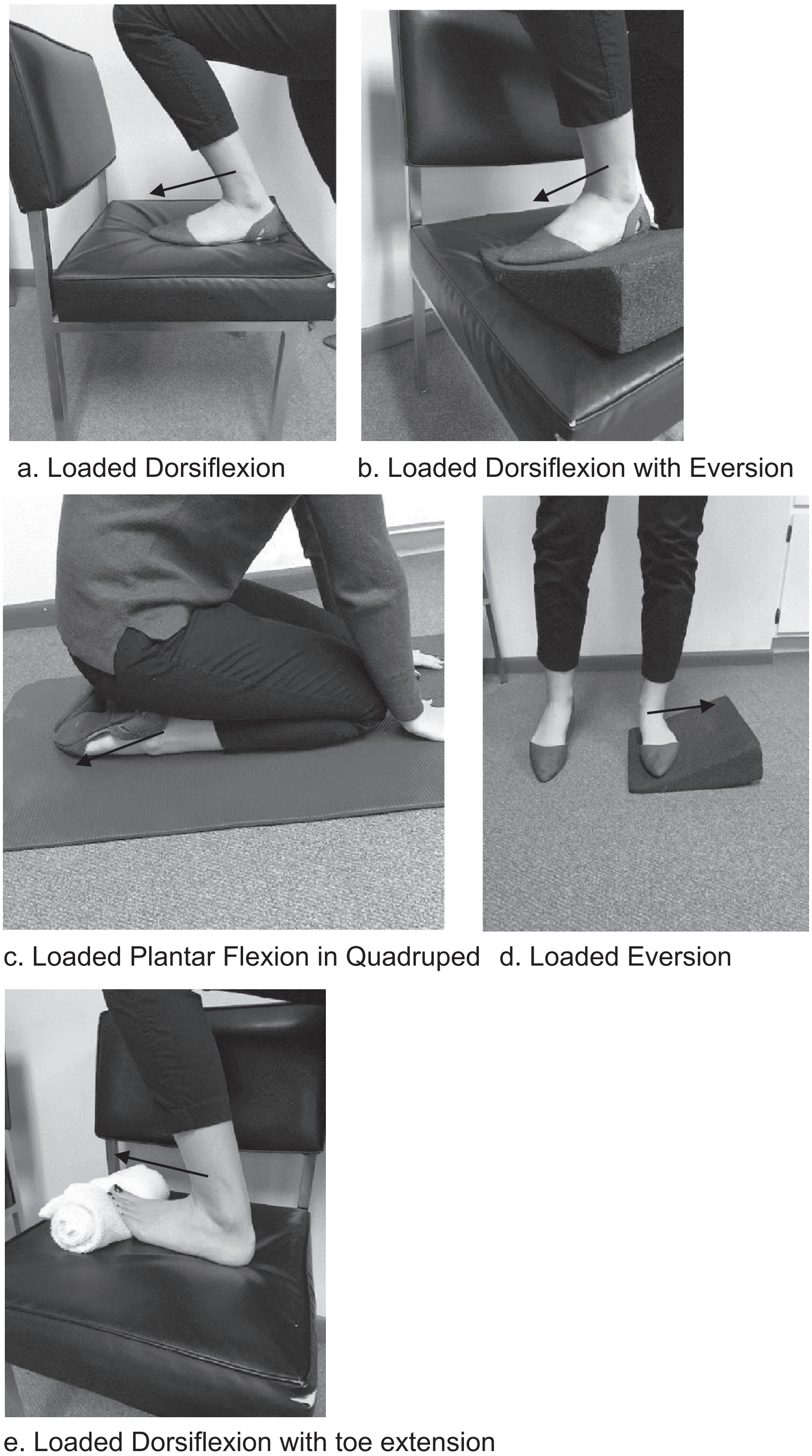

Figure 1. Ankle loading strategies (a) Loaded dorsiflexion, (b) Loaded dorsiflexion with eversion, (c) Loaded plantar flexion in quadruped, (d) Loaded eversion, (e) Loaded dorsiflexion with toe extension.

indicating 47.5% of complete function, and average NPRS was 6/10.

Examination and clinical impression

Upon physical examination, medial ankle pain was produced with palpation and 1/4″ swelling was noted, using circumferential measurement around the distal lower leg just proximal to the malleoli, compared to the opposite side. Range of motion assessment revealed no loss of movement however there was pain with active dorsiflexion.

Loaded ankle dorsiflexion (Figure 1(a)) had no effect on symptoms or pain with active dorsiflexion. Loaded plantar flexion in quadruped (Figure 1(c)) resulted in significant decrease in pain with palpation, and also with active dorsiflexion.

No further movement testing or treatment was required given the positive response. The rapid reduction in painful baselines that occurred on the initial visit suggests that pain is not driven from an inflammatory state nor her medical diagnosis of posterior tibialis tendonitis. This presentation fits the provisional classification of ankle derangement, with a directional preference of loaded plantar flexion in quadruped (Figure 1(c)). The patient was instructed to perform 10 repetitions of loaded plantar flexion in quadruped every 2 h.

Intervention, follow up, and outcome

Forty-eight hours later, the patient reported localization of symptoms to the medial ankle, a positive prognostic report [18]. Despite that, she still reported pain with active dorsiflexion which remained unchanged after thoroughly exhausting the sagittal plane, and therefore lateral techniques were explored [18]. Loaded eversion of the ankle was performed (Figure 1(d)), with a significant decrease in point tenderness and pain with active dorsiflexion, although still not abolished. Given positive symptomatic response, the patient was advised to continue with loaded eversion for the next 3 days before reassessment. She was instructed to perform 10 repetitions of loaded eversion every 2 h. She required no further changes in management or directional preference or force progressions during her treatment. The following visits were focused on returning the patient back to a pain-free walking program which was successful.

The patient was seen for six visits over 16 days with abolishment of symptoms and swelling and ability to self-reduce any recurrences. She was discharged from supervised therapy and instructed to continue loaded eversion as needed and to continue with her treadmill walking program.

Four months after discharge, the patient was interviewed in-person and reported no re-occurrence of symptoms or functional deficit. She stated she no longer needed to perform loaded eversion and stopped doing so soon after discharging. The patient was able to return to her usual walking program on the treadmill with no associated symptoms.

Case 3

Patient characteristics

A 66-year-old female was referred to physical therapy by an orthopedic physician assistant with the medical diagnosis of plantar fasciitis. Right heel pain was intermittent, affecting 76–100% of her day, commenced 2 weeks prior for no apparent reason, and had been worsening since onset. Symptoms were worse with weight bearing, walking, standing, negotiating stairs, initial few steps after rising, and the morning hours. Her LEFS score was 26/80, indicating 32.5% of complete function. Average NPRS of 5.5/10; ranging from 4/10 to 7/10.

Examination and clinical impression

Upon physical examination, the patient reported increase in pain with standing. Range of motion assessment revealed a moderate loss of ankle dorsiflexion and minimal loss of plantar flexion, inversion, and eversion. Manual muscle testing found general ankle strength deficit of 4/5 throughout.

Testing of repeated-loaded ankle dorsiflexion (Figure 1(a)) produced pain at end-range that was no worse. Afterward there was a significant increase in dorsiflexion range of motion noted, greater than her left. Upon standing she reported abolishment of symptoms.

No further movement testing or treatment was required given the positive response. The rapid reduction in painful baselines that occurred on the initial visit suggests that pain is not driven from an inflammatory state nor her medical diagnosis of plantar fasciitis [23]. This presentation fits the provisional classification of ankle derangement, with a directional preference of loaded dorsiflexion. The patient was instructed to perform 10 repetitions of loaded dorsiflexion every 2 h.

Intervention, follow up, and outcome

Re-assessment occurred 4 days later. Patient reported that loaded dorsiflexion would consistently abolish her symptoms and allow her to walk 50 feet before symptoms returned. Due to positive response that was not lasting, the treating clinician increased force into this directional preference by applying mobilization with movement into dorsiflexion in order to achieve further end-range dorsiflexion, as described by Collins et al. [24]. This allowed her to walk 100 feet with minimal symptoms (1/10) which did not change. She required increased force to achieve symptom reduction, and therefore was instructed to place a towel roll under the metatarsal heads to increase the dorsiflexion end-range force (Figure 1(e)). The patient was instructed to perform 10 repetitions of loaded dorsiflexion with toe extension every 2 h. She required no further changes in management or directional preference or force progressions during her treatment. The following visits were focused on balance training and assuring she was not at risk for falls after this ankle injury, given her older age.

The patient was seen for six visits over 21 days with abolishment of symptoms and ability to self-reduce any recurrences. She was discharged from supervised therapy and two months later was interviewed in-person reported no recurrence of heel pain and no longer needed to perform loaded dorsiflexion with toe extension.

Case 4

Patient characteristics

A 72-year-old female was referred to physical therapy by her podiatrist for the medical diagnosis of right second metatarsophalangeal joint (MPJ) pain and edema. The podiatrist issued her a mesh post-op shoe for ambulation. She reported intermittent right MPJ pain affecting 75–100% of her day. There was pain at rest. The patient's symptoms commenced 3 weeks prior for no apparent reason. Symptoms were reported worse with weight bearing, walking, and standing. Her LEFS score was 45/80, indicating 56% of complete function, and average NPRS of 8/10. The patient also had a previous history of lumbar spine derangement which had fully resolved at time of discharge.

Examination and clinical impression

The patient reported plantar pain around the 2nd MPJ of the right foot. Range of motion assessment revealed a moderate loss of all ankle movements. She also displayed moderate loss of lumbar extension.

Due to significant loss of lumbar mobility and patient's previous history, a diagnostic mechanical screen of her lumbar spine was performed. Assessment of 15 repetitions of lumbar extension in standing [15], resulted in abolishment of MPJ pain with ambulation.

No further movement testing or treatment was required given the positive response. The rapid reduction in painful baselines that occurred on the initial visit suggests that pain is not driven from an inflammatory state nor her medical diagnosis of MPJ pain and edema, or any other structure in the foot-ankle complex. This presentation fits the provisional classification of lumbar derangement with isolated MPJ pain referral, with a directional preference of loaded lumbar extension in standing as well as posture correction in sitting using a standard lumbar roll. The patient was instructed to perform 10 repetitions of extension in standing every 2 h and use a standard lumbar roll anytime she was sitting.

Intervention, follow up, and outcome

On the third visit, she reported 30% perceived improvement in her overall condition, but no further improvement since the previous visit; however, she had stopped wearing the walking slipper, an indication of functional change, and therefore treatment strategy was unaltered that day. She returned the next session with a 60% perceived improvement in her overall condition. She no longer reported right MPJ pain, but was now reporting right hip pain. Repeated lumbar extension in standing had no effect on right hip pain. Although the symptom had centralized to the hip, it was no longer effected by sagittal plane movements and therefore lateral procedures were assessed. Repeated right side gliding [15] reduced hip pain, and therefore her directional preference was changed to repeated right side gliding on the wall. She was instructed to perform 10 repetitions of right side gliding every 2 h. She returned the next session reporting 70% improvement but still not full reduction of symptoms, therefore the treating clinician decided to continue with lateral procedures (i.e. right side gliding) longer before returning back to the sagittal plane the following visit. She returned to functional activities and bending one week later without hip or MPJ pain.

The patient was seen for eight visits over 33 days with abolishment of symptoms and ability to self-reduce any recurrences. She was discharged from supervised therapy and instructed to continue with lumbar extension twice daily. Eight weeks after discharge the patient reported, via phone interview, no recurrence of symptoms and was able to walk without pain. She continued to no longer wear the mesh post-op shoe and sought no other medical treatment for her condition.

Discussion

This case series presents patients with various acute/subacute pain of the ankle-foot complex classified as ankle and lumbar derangements, managed using MDT principles and treatment strategies.

If general treatment protocols [2,25–28] proposed for ankle-foot pain were utilized in management of these patients, exercises that were shown to worsen symptoms may have been utilized. The ability to worsen patient symptoms with the opposite directional preference has also been demonstrated during movement testing in the TMJ, shoulder, elbow, wrist, thumb, knee and shoulder, although never tested in form of randomized control trial [3,4,6,9,11,29]. It is unclear how this would affect the patients' outcome. Long et al. [30,31] have clearly established that in the presence of derangement syndrome, matching directional preference improves clinical outcomes. Also, matching opposite directional preference worsens clinical outcomes, and giving a non-specific exercise program is less effective than matching directional preference [30,31]. Perhaps this is why general treatment guidelines are progressed over several weeks [2,25,28] with a slow return to functional activities [25], rather than the rapid response seen in these four cases.

The exact anatomical or physiological cause of derangement is unclear, although it has been theorized in the literature. Recent MDT extremity research [5,9,11] cite the surgical findings of Mercer and Bogduk [32], who found innervated, migrant structures which can cause obstruction to movement and pain, the characteristics of derangement syndrome [18]. Similar meniscoid displacement has been found in the ankle joint [33,34]. An alternative theory is joint malalignment without soft tissue displacement, causing pain and obstruction with movement [35], often referred to as a positional fault [36].

Lai and Levinston [37] have also shown meniscal tissue within the knee to be deformable, and have ability to remodel in response to compression. Other research has suggested joint mobilization may cause a hypoalgesic and sympathoexitatory effect, inhibiting pain generation [36]. Although the exact tissue, or mechanism, for the rapid change occurring in joint derangement remains unclear, research is strongly supportive of end-range joint loading or joint mobilization for several reasons, and further research should be performed [32–37]. Further research is also needed to establish superiority of matched directional preference treatment compared to non-specific exercise program in the extremities in a random, controlled setting.

A limitation of this study was the non-consecutive patient selection; however, this allowed for demonstration of efficient MDT management among clinicians of various levels of MDT training, improving the generalizability of these results. The patient in Case 1 was originally presented as a case report at the 14th International Conference in Mechanical Diagnosis and Therapy [36]. The three subsequent cases were added to improve the level of evidence and clinical strength of this paper and includes the first discharged patient from each clinician with the primary complaint of foot or ankle pain. This case series also demonstrates the importance of assessing the lumbar spine in the presence lower extremity pain, as the final case had a primary complaint of isolated foot pain with peripheral diagnosis from a podiatrist; however, her symptoms were purely the result of a relevant lateral spinal derangement and resolved fully following the sole application of repeated movements of the lumbar spine.

Conclusion

This case series demonstrates the rapid and long-lasting mechanical and symptomatic change in patients with ankle-foot complex pain and dysfunction. The outcome far surpassed that of a traditional rehabilitation program in a much shorter time frame [2,25,28]. The rapid reversibility of these patients' condition questions the current understanding of etiology involved in ankle-foot conditions. Further research needs to be conducted on the implementation of MDT in managing musculoskeletal ankle pathologies in larger samples.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Lindsay Carlton is an athletic trainer and doctor of physical therapy with Credentials in Mechanical Diagnosis and Therapy (MDT). She is published in the application of MDT in the wrist and after failed anterior cervical fusion and discectomy. She has presented numerous posters at national and international MDT conferences regarding ankle, lumbar, cervical, elbow, and hip pain. She is also involved in on-site course coordination with the McKenzie Institute USA and was awarded the Ron Bybee Scholarship Award in 2017 by the McKenzie Institute USA.

Joseph R. Maccio is a doctor of physical therapy and holds a diploma in Mechanical Diagnosis and Therapy (MDT). He too is published in the application of MDT in the wrist, after failed anterior cervical fusion and discectomy, and lateral epicondylagia. He has given a platform presentation at the McKenzie Americas Conference detailing the prevalence of directional preference at the wrist. He has also presented numerous posters at national and international MDT conferences regarding ankle, lumbar, cervical, elbow, and hip pain. He is the Clinical Instructor (CI) for a MDT-specific clinical rotation for doctoral physical therapy students.

Joseph G. Maccio is a physical therapist with a Masters' in Ergonomics and holds a diploma in Mechanical Diagnosis and Therapy (MDT). He has several publications in the application of MDT in the wrist and after failed cervical fusion. He has also presented numerous posters at national and international MDT conferences regarding ankle, lumbar, cervical, elbow, and hip pain. He is an adjunct lector at Sage Colleges for the doctoral physical therapy students, lecturing on spinal assessment and ergonomics. He also provides continuing education lectures regarding MDT assessment at the primary care level to Nurse Practitioners at their New York State conference.

Andrew Braga is a doctor of physical therapy who completed a 10-week clinical rotation at Maccio Physical Therapy as part of his doctoral training. He has completed the first two preliminary MDT educational components.

Elizabeth Tomanio is a doctor of physical therapy who completed a 10-week clinical rotation at Maccio Physical Therapy as part of her doctoral training. She has completed the first two preliminary MDT educational components.

Anastasia Belikov is a doctor of physical therapy who completed a 12-week clinical rotation at Maccio Physical Therapy as part of her doctoral training. She has completed the first three preliminary MDT educational components.

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