2018

Use of Dry Needling Therapy as an Adjunct to Physical Therapy Treatment of an Individual with Knee Pain Complicated by Joint Hypermobility Syndrome: A Case Report

Kaitlyn Kincart
University of Iowa

Use of Dry Needling Therapy as an Adjunct to Physical Therapy Treatment of an Individual with Knee Pain Complicated by Joint Hypermobility Syndrome: A Case Report

Kaitlyn Kincart

DPT Class of 2018
Department of Physical Therapy & Rehabilitation Science
The University of Iowa

Abstract

Background: Joint hypermobility syndrome is an overarching term for a variety of disorders relating to abnormalities in tissue extensibility. Dry needling is an intervention that is growing in popularity to treat musculoskeletal pain often by targeting trigger points. The purpose of this case report is to present how dry needling techniques were used as part of the plan of care for an individual with knee pain complicated by hypermobility syndrome. **Case Description:** The patient was a middle-aged nurse with complaints of right knee pain, who presented with increased tone throughout her posterior lower extremity musculature. Due to the pain, she modified her activity levels and work duties. **Intervention:** The therapist performed dry needling techniques to the right posterior lower extremity musculature with a focus on improving tissue extensibility and reducing pain at the beginning of her treatment. Additional treatments including neuromuscular re-education, therapeutic exercises and manual therapy were subsequently performed. **Discussion:** Dry needling was used initially to promote decreased symptoms and improved tissue mechanics in order to begin stability training to further reduce pain. At the end of therapy, the patient had a clear decrease in pain and improvement in her ability to perform functional tasks and activities.

Keywords: Dry needling; knee pain; hypermobility syndrome; orthopedics; physical therapy; rehabilitation

Background

Hypermobility spectrum disorder (HSD), previously known as joint hypermobility syndrome (JHS), is an overarching term that encompasses a spectrum of connective tissue disorders[8]. The two most common disorders now placed under HSD are JHS and Ehlers-Danlos syndrome (EDS), but this grouping also includes lateral meningocele syndrome, disorders of the transforming growth factor- beta (TGF-B) pathway and cutis laxa syndrome[3]. These syndromes often have the common variable of joint hypermobility with joint instability, fragility and laxity of different tissues, as well as chronic pain[12]. However, the syndromes can be unique in other areas including cardiovascular, respiratory, and autonomic systems[3]. In 2017, it was estimated that 0.75-2% of the general public have JHS, with an increased prevalence in women[12]. However, JHS is thought to be often undiagnosed, so an accurate prevalence is unknown[8]. JHS can significantly affect a patient's life, commonly leading to disability with functional activities like walking, running, participation in sports, and even personal hygiene[12].

Certain musculoskeletal clinical impairments have been found to be common amongst those with JHS. Due to the laxity in the connective tissue, there is an increase in prevalence of joint sprains, as well as ligament and tendon injuries[8]. It is also common for these patients to have problems with joint subluxations or dislocation, including patellofemoral joint instability with tracking[8]. Along with these musculoskeletal manifestations, chronic widespread and localized pain is also common as is psychosocial factors like anxiety, depression, and fatigue[8].

Table 1. 1998 Diagnostic Criteria for JHS (Brighton Criteria)[8]

Major Criteria

1. Beighton score of 4/9 or greater (currently or historically)
2. Arthralgia for longer than three months in four or more joints

Minor Criteria

1. A Beighton score of 1-3/9 if age greater than 50 years
2. Arthralgia for longer than 3 months in 1-3 joints; back pain for 3 months or more; or spondylosis, spondylolysis, or spondylolisthesis
3. Dislocation or subluxation in more than one joint, or in one joint on more than one occasion
4. Soft tissue rheumatism (eg, epicondylitis, tenosynovitis, bursitis) in three or more locations
5. Marfanoid habitus
6. Abnormal skin (eg, striae, hyperextensiblity, thin skin, papyraceous scarring)
7. Eye abnormalities (eg, drooping eyelids, myopia, or "anti-mongoloid" slant)
8. Varicose veins, hernia, or uterine/ rectal prolapse

JHS is diagnosed clinically, combining information received in the medical history and the Brighton 1998 Criteria (Table 1), which encompasses the Beighton Hypermobility Score (Table 2)[8]. JHS is diagnosed if two major criteria, one major and two minor criteria, or four minor criteria are present. However, if a first-degree relative is unequivocally affected, two minor criteria suffice. JHS is excluded if Marfan or EDS (other than EDS-hypermobility) is present. The first major and minor criteria and the second major and minor criteria are mutually exclusive. One distinction between JHS and Ehlers-Danlos Syndrome is that EDS also requires genetic testing or analysis of collagen from a skin biopsy to be diagnosed.

Table 2. Beighton Score for Joint Hypermobility

Demonstrating ability to:	**Left**	**Right**
Passively dorsiflex the fifth metacarpophalangeal joint by at least 90°		
Oppose the thumb to the volar aspect of the ipsilateral forearm		
Hyperextend the elbow at least 10°		
Hyperextend the knee at least 10°		
Place hands flat on floor without bending knees		

Evaluation and treatment with physical therapy is often needed at some point in the lives of patients with JHS. Literature reviews suggest that essential physical therapy interventions include education, strengthening with an emphasis

on use of closed kinetic chain tasks, and stabilization exercises[12]. Stretching is not typically indicated due to the hypermobility in the tissues. Additionally, with it being common for those with JHS to have impairments with proprioception, stabilization exercises are often highly recommended[8]. With physical therapy interventions, it may be important to consider issuing splints or adaptive devices for joint alignment and stability[8].

Dry needling is an intervention that has been used in the practice of physical therapists across the world since the 1980s[14]. The American Physical Therapy Association (APTA) defines dry needling as the "skilled technique performed by a physical therapist using filiform needles to penetrate the skin and/or underlying tissues to affect change in body structures and functions for evaluation and management of neuromusculoskeletal conditions, pain, movement impairments and disability".[2] Although therapists performing dry needling techniques use similar filiform needles as used in acupuncture, the two practices differ when addressing their upbringing. While acupuncture is an eastern-based treatment with use of multiple needles, dry needling falls into western-based teachings and scientific studying of the musculoskeletal and nervous systems of the human body[1]. Dry needling was determined to be within the scope of physical therapy practice starting in 2009 by the American Academy of Orthopedic Manual Physical Therapy and is currently used as an adjunct to interventions in 33 of the 50 United States[4,5]. Physical therapists encompass the skills as a profession to perform dry needling due to the extensive didactic and clinical knowledge studied in anatomy, kinesiology, communication, and overall patient evaluation of differential diagnoses[4]. With dry needling, it is also essential for physical therapists to have the expertise with palpation to identify subtle differences in the muscle's compliance in order to properly and safely perform the technique[5]. Dry needling is not considered an entry-level intervention, therefore if physical therapists want to perform dry needling, the APTA's Task Force states they must complete additional educational coursework[4]. This training includes completing hands-on examinations in order to demonstrate competency[4].

While there are many techniques for dry needling, the most common and well-supported approach is to target myofascial trigger points[5]. Myofascial trigger points are highly sensitive areas in skeletal muscle that reside at the motor end plate. The trigger points provide constant peripheral nociceptive input to the dorsal horn and can either be latent or active[5]. Latent myofascial trigger points will not be painful spontaneously, but will become symptomatic when direct deep pressure is applied[5]. On the other hand, active myofascial trigger points, also known as secondary hyperalgesic loci, are highly irritable and spontaneously symptomatic, embedded within skeletal muscle taut bands[13]. The trigger points are known to have areas of local ischemia and hypoxia, as well an acidic environment that interferes with chemical balances. These trigger points also can produce pain locally, send pain through referral patterns, and/ or downgrade activation patterns of muscles[2]. While it has been documented that the nociceptive input at these active trigger points leads to peripheral and central pain sensitization, it has also been shown that the use of manual techniques including dry needling can reduce and reverse some of those affects[5]. When

Table 3. APTA's Procedural Text for Application of Dry Needling Techniques as an Intervention[2]

1. Explain the mechanism and procedure to the patient
2. Palpate the muscle for a taut band and its trigger point
3. Guide the filiform needle toward the trigger point until resistance is felt and/ or local twitch response occurs
4. Draw the needle back toward the subcutaneous tissue and redirect the needle into the remaining trigger point areas
5. Remove needle when the local twitch responses decrease in frequency, the overall tissue resistance is reduced, or patient intolerance
6. Apply pressure over the insertion to prevent possible swelling or soreness
7. Re-palpation the tissue and reassess its muscular properties

the needle penetrates into an active trigger point properly, dry needling induces a local twitch response of the muscle[2]. That local twitch response is a spinal cord reflex of involuntary contraction of the skeletal muscle's taut band[2]. With this involuntary electrical activity, it has been documented that there is a spontaneous reduction in chemicals at the motor end plate which relax the taut band and restoring circulation in that muscle fiber[2]. In other words, after the local twitch response, there is an immediate decrease in pain, tenderness, and sensitizations, as well as a regularization of the synaptic processes.

Dry needling has been well-studied to show advantages when used in treatment of myofascial pain. These benefits include reduction in local, referred, and widespread pain, as well as improvement in tissue extensibility, range of motion, and muscular contraction activation sequencing, and normalization the chemical environments of the trigger point[5]. It is important to note that other manual therapy practices can provide the same relief of trigger points, but dry needling reaches those beneficial effects more quickly and efficiently[5]. While there are mixed results reported in the literature, many studies have found dry needling to be effective. However, dry needling not commonly used as a therapist's only intervention, rather is most often an adjunct within the mixture of other manual therapy techniques such as joint and soft tissue mobilization[5].

Case Description

A middle-aged woman presented to physical therapy with complaints of right hamstring and calf tightness concurrent with right knee pain. The patient had a history of hypermobility disorder which complicates the case.

History of Chief Complaint

The patient had a flare-up of asthma and inflammation in her joints one morning, which she noted was common to happen during allergy season. That day she went for her normal 3-4 mile walk and throughout the walk, her knees felt achy. The next morning, she woke up and could hardly bear weight on her right leg due to pain throughout the leg, and therefore she took the day off from her job as a nurse at a local hospital. The following day, her pain had decreased and she was able to return to work but she was unable to finish her shift due to a return in the right leg pain. The pain persisted until she decided she needed to go to the emergency department due to the sharp pain and inability to bare weight through the right lower extremity. Radiographs were obtained, finding a Baker's cyst and a bone spur on her right knee, concurrent with osteoarthritis. She was prescribed a high dosage of an anti-inflammatory medication and sent home. The patient also had complaints of instability throughout her right knee joint along with the pain. She presented to physical therapy the day after her emergency department visit via direct access for evaluation and treatment of the right leg symptoms.

The patient had an antalgic gait on her right lower extremity. She described her knee pain as achy and felt tight throughout the right hamstring and calf. She rated her right lower extremity pain a 4/10 while sitting, but stated in the last few days had been as bad as a 10/10 at its worst. Her pain was aggravated by standing, walking, and going down stairs, where she had to lead with right foot in a step-to sequence. Her pain was eased through compression stockings, icing, anti-inflammatory medication and a muscle relaxant. She described her pain as being intermittent throughout the day and noted that she had trouble falling asleep due to the pain. The patient's goals were to decrease her right knee pain and the tightness through her right hamstring and calf in order to return to full work duties as well as recreational walking.

Past Medical History

The patient had a history of osteoarthritis in bilateral knees and hypermobility syndrome, affecting her joints. She also reported a history of asthma.

Examination and Evaluation

The evaluation focused on assessment of functional activities, range of motion, strength, and muscular properties in the lower extremities. Through a functional assessment, it was noted that the patient favored the right lower extremity with decreased weight bearing when completing a sit to stand, standing, and through gait. The patient ambulated with a slow cadence, forward flexed posture, and antalgic appearance to her gait. Upon inspection, it was noted that non-pitting edema was present on her right lateral knee along with a Baker's cysts present on her posteriolateral right knee.

The patient's mobility was measured through range of motion, using goniometry. The patient's left lower extremity range of motion exceeded normal limits due to hypermobility and was asymptomatic throughout. Her right hip passive range of motion was within normal limits for flexion and internal rotation, but lacked 20° from full external rotation and she reported pain in her gluteal and sacroiliac region throughout the movements. Her right knee passive range of motion was also within normal limits but she stated she felt a pull on through her hamstring during the movements. Her right ankle dorsiflexion passive range of motion with knee extension measured to neutral with complaints of tightness through gastrocnemius-soleus. Her right hamstring length was also limited when measuring via the 90/90 hamstring flexibility test, lacking 10° from full extension.

The patient's strength was tested using manual muscle testing positions described in Daniels and Worthingham's Muscle Testing.[10] Her only measured strength deficit was right hip abduction at 4/5. It was noted during right hip extension strength testing that she lacked proper gluteal activation and sequencing. It was also found that when asked to tighten and activate her quadriceps muscles while sitting with her knees in full extension, her right quadriceps had decreased activation and ability to control the patella through movement pattern.

The patient's right patellofemoral passive mobility was hypomobile throughout all movements but normal on the left. Anterior and posterior drawer tests to assess knee ligament stability demonstrated increased laxity through left knee and severe guarding by hamstrings and quadriceps on right knee, which therefore meant the tests were unable to be properly assessed. However, the valgus and varus stress tests for knee ligament stability presented laxity bilaterally, fitting with the patient's known hypermobility.

Throughout the evaluation, palpation was also used as an assessment tool. There were no restrictions through the left lower extremity but notable increased tone with active myofascial trigger points in the right hamstring, gluteus medius, piriformis, and gastrocnemius muscles.

Diagnosis and Prognosis

Upon completion of this patient's evaluation, the therapist concluded that the trigger points and muscle imbalances observed throughout the right lower extremity could be a contributing factor and/ or associated to the pain. This conclusion was brought about by the increased tone and myofascial trigger points evident, the patient's description of a pull and stretch with movements, and the decreased activation of right lower extremity musculature. Her diagnosis and prognosis were complicated by her

history of hypermobility syndrome, with increased laxity and full range of motion noted throughout joints that will inhibit progress that stretching of the taut muscles would allow.

Intervention

To begin treatment, a focus on reducing muscle tension and tone as well as improving activation of musculature was the goal for interventions. The initial intervention used was dry needling to the right gluteus medius, piriformis, hamstring, and gastrocnemius muscles with subsequent performance of manual therapy soft tissue mobilization of those same muscles. With the patient positioned in prone, dry needling was performed by the physical therapist using Sierin Acupuncture Needles, size 30 mm x 50 mm to the palpated myofascial trigger points with excellent twitch response and immediate relaxation of muscles. Following the initial dry needling, the patient reported a decrease in pain throughout the right posterior lower extremity along with improved activation of the right quadriceps. Additionally, the right gluteus medius manual muscle test measured 5/5 strength following the dry needling and manual therapy. It was also noted that the patient had improved weight bearing and decreased pain during gait sequencing. The dry needling would be utilized as an "as needed" intervention throughout the plan of care as it was only to be an adjunct into therapy, which would help the treatment progress to where the patient would be more actively involved in care.

In addition to dry needling, instruction of the therapeutic exercise "quad set", also known as "thigh squeezes" were performed. These were included to promote continued advancement of quadriceps activation and knee stability as well as apply proprioceptive training to the right anterior knee to address the instability the patient had experienced.

Treatment 2

The patient noted that she had gotten some pain relief but she still felt unstable in the right knee. She also had a lot of pull through the right posterior leg at work and had to limit her work activities. She presented with continued slow, antalgic gait with increase pain in the right knee along with genu recurvatum through the right knee in stance phase. However, the gait sequencing appeared more fluid than observed on the evaluative date. She continued to favor the right lower extremity with transitional movements like the sit to stand. With palpation, it was evident the right quadratus lumborum, gluteus minimus, and piriformis muscles continued to have taut bands with active myofascial trigger points. The hamstrings and gastrocnemius muscles continued to have increased tone, but no taut bands or active trigger points. Interventions continued to focus on decreasing muscular tone and tenderness as well as improving activation of muscles involved. Using the same technique as previously described on the evaluation day, the physical therapist performed dry needling on the patient's right quadratus lumborum, gluteus minimus, and piriformis with excellent twitch responses present. Decreased tone through these muscles as well as through the hamstring and gastrocnemius was evident following dry needling. It was not indicated to perform dry needling on the hamstring or gastrocnemius at this time. Moderate to deep soft tissue mobilization to the right piriformis, gluteus minimus, quadratus lumborum, hamstring, and gastrocnemius. Following treatment, the patient was able to equalize weight bearing when performing sit-to-stand as well as demonstrated a decrease in pain during gait. The patient was again educated with cuing for facilitation of quadriceps set for the right lower extremity in order to improve activation and stability through the right knee.

Treatments 3-7

Upon return visits, the patient reported an improvement in right lower extremity symptoms, specifically noted feeling less tightness through the posterior musculature. Through the subsequent treatments, a focus was put on performing soft tissue mobilization to the posterior lower extremity

musculature to decrease the tone and improve the tissue extensibility. This area had increased tone with palpation but no taut bands or active myofascial trigger points, demonstrating that dry needling was no longer indicated for the patient. Other focuses for the treatments were continuing to normalize the patient's quadriceps activation as well as improve right patella mobility with distraction and medial, superior and inferior patellofemoral glides as hypomobility and difficulty with patellar tracking was observed during the evaluation. Interventions also focused on improving the patient's return to work and activity protocols, as the patient's pain had flared-up again after a long and busy weekend shift at work. Recommendations were made and the patient was educated on trialing use of stationary bike for exercise and then slowly transitioning into increased mileage for walking. The patient was also educated on lifting mechanics and importance of seated breaks throughout work shift as allowed in order to reduce risk of inducing more pain. Finally, the patient was also treated with iontophoresis during treatment #6 in response to slight increase in inflammation at the right pes anserine following a heavy work shift the previous day. The iontophoresis was used with dexamethasone at 1.9 mA for 16 minutes.

The patient was seen for a total of 7 visits over 7 weeks before developing lower back pain after picking an object up from the floor. From there, the patient's interventions and plan of care was transitioned to addressing the lower back, thus is not included in this case report.

Outcomes and Outcome Measures

At the final visit to treat the right knee, the patient presented with current pain rated 0/10 and worst pain over the previous week rated 1/10. The patient's right hamstring flexibility was normalized throughout the treatment. The patient was also able to complete a 2-mile walk and full work shifts with only slight tightness experienced in her posterior leg. The patient was able to ascend and descend stairs with a step-over-step sequence, pain-free. With palpation, there was a notable decrease and normalization of tone throughout the posterior lower extremity when compared bilaterally. The right patella-femoral tracking was also improved. The patient was able to complete quadriceps activation equally bilaterally and had full strength through the hips, knees, and ankles bilaterally, measuring 5/5 on manual muscle testing.

While there were few objective outcome measures compared initially and at the end of care, the patient's pain rating was collected via the 11-point numerical rating scale (NRS). Initially the pain was rated 4/10 at rest and 10/10 at its worst. At the end of the treatment, she ranked her pain at 0/10 at rest and 1/10 at its worst. In the literature, the NRS has been studied for validation, reliability and a minimal clinically important differences (MCID) has been determined in various populations, but not all sources seem to agree. In a study involving subjects with chronic musculoskeletal pain by Salaffi et. al, it was found that a change of one point represented an MCID, while a change in two points concluded that the patient was "much better".[11] On the other hand, Farrar et al., studied chronic pain patients, and found the MCID to be 1.7 points[7]. Herr et. al, focused on healthy subjects and found there was excellent interrater reliability as well as excellent internal consistency for the NRS on participants 25-94 years old[9]. Additionally, that study demonstrated that the NRS also had excellent correlation and concurrent validity when compared to the visual analogue scale, verbal descriptor scale, and faces pain scale[9]. Furthermore, the NRS was also the most preferred scale by both the older and younger groups when compared to those other scales[9]. Nevertheless, the patient had a 4-point improvement in her resting pain and a 9-point improvement in her worst pain ratings, indicating on all scales a clinically important difference.

Additionally, another tool used for pre-and post- treatment was use of manual muscle testing of the lower extremity. Her hip abduction improved from 4/5 strength to 5/5 after her initial dry needling, at the initial visit. According to Dvir, he found that it is hard to quantify and remain accurate and reproducible with manual muscle testing[6]. He reported that the responsiveness of manual muscle testing is poor, and that it takes at least a 35% change in the total force of the contractile tissues to see a true change in manual muscle testing grades[6]. Thus, it is more difficult to state with confidence that the patient's strength improved based on the the manual muscle testing, however this was in part limited by her nearly normal strength levels to begin with, suggesting a ceiling effect occurred.

Discussion

The purpose of this case study was to present how dry needling techniques were used in adjunct for physical therapy treatment of lower extremity pain in a middle-aged woman with a history of hypermobility syndrome. This case highlights one example in which the patient's progress exceeded the MCID for the NRS pain rating scale, suggesting dry needling may be a safe and useful intervention to augment other more traditional approaches. Additionally, her subjective history and improvement in functional activities further support that a positive outcome resulted following this patient's plan of care. While dry needling did not eliminate the symptoms of right knee pain, the patient had a positive response in reducing pain following the treatment with an almost immediate improvement in function. The therapist utilized dry needling as an intervention as she believed that it was beneficial to reduce the tone and restore the proper chemical environment within the muscle to reduce the patient's complaints of stiffness. As stated earlier, stretching is not commonly indicated as an intervention for those with JHS even with complaints of stiffness, as there is often a normalized range of motion in their joints. For that reason, dry needling was a viable option to use for an intervention. It was also used combined with traditional manual therapy techniques in this patient's plan of care. As indicated above, these interventions have been found in the literature to have the same effects, but dry needling provides those changes and potential benefits quicker and more efficiently. With the positive effects of the reduced tissue tone, improvement in muscular activation and strength, and decreased pain, dry needling was a successful intervention in this patient with knee pain complicated by JHS.

There is little evidence to support the use of dry needling as the sole focus for treatment, but rather may play a role as an adjunct treatment to improve a patient's symptoms and/ or muscular tone in order to tolerate other interventions such as exercises targeting joint stability. Further evaluation needs to be done that focuses on dry needling use as an intervention to treat the pain and stiffness in patients with JHS, however the variable presentations associated with this class of conditions adds to the challenges in identifying universally effective interventions. While it would have been beneficial to have utilized more valid and reliable outcome measures, this case provides one example of the incorporation of dry needling techniques with other manual, therapeutic exercise, and stabilization interventions for the treatment of knee pain in an individual with joint hypermobility syndrome.

References

1. American Physical Therapy Association (2012). Physical Therapists and the Performance of Dry Needling. APTA Department of Practice, APTA State Government Affairs, ed.
2. American Physical Therapy Association (2013). Description of Dry Needling in Clinical Practice. APTA Public Policy, Practice and Professional Affairs Unit, ed.
3. Baban, A., Castori, M. (2018) Pharmacological resources, diagnostic approach and coordination of care in joint hypermobility-related disorders, *Expert Review of Clinical Pharmacology.*; *11*:7, 689-703

4. Caramagno J, Adrian L, Muller L, Purl J, (2015). American Physical Therapy Association. Analysis of Competencies for Dry Needling by Physical Therapists. *Human Resources Research Organization.*; (033).
5. Dommerholt J. (2011) Dry needling — peripheral and central considerations. *The Journal of Manual & Manipulative Therapy*.;*19*(4): 223-227.
6. Dvir, Z. (2015). Difference, significant difference and clinically meaningful difference: The meaning of change in rehabilitation. *Journal of exercise rehabilitation*, *11*(2), 67-73.
7. Farrar, J. T., Young, J. P., Lamoreaux, L., Werth, J. L., & Poole, M. R. (2001). Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain.; 94*(2), 149-158.
8. Grahame, R, Hakim, A. J., ed. Schur, P. H., Romain, P.L (2018). Joint Hypermobility Syndrome. *UpToDate*.
9. Herr, K. A., Spratt, K., Mobily, P. R., Giovanna, R. (2004). "Pain intensity assessment in older adults: use of experimental pain to compare psychometric properties and usability of selected pain scales with younger adults." *Clin J Pain; 20*(4): 207-219.
10. Hislop, H. J., Avers, D., Brown, M., & Daniels, L. (2014) *Daniels and Worthingham's muscle testing: Techniques of manual examination and performance testing.* St. Louis, MO: Elsevier/ Saunders.
11. Salaffi, F., Stancati, A. , Silvestri, C. A., Ciapetti, A. and Grassi, W. (2004), Minimal clinically important changes in chronic musculoskeletal pain intensity measured on a numerical rating scale. *European Journal of Pain; 8*: 283-291.
12. Simmonds, J. V., Herbland, A., Hakim, A., Ninis, N., Lever, W., Aziz, Q. & Cairns, M. (2017) Exercise beliefs and behaviours of individuals with Joint Hypermobility syndrome/Ehlers–Danlos Syndrome – Hypermobility Type. *Disability and Rehabilitation.*
13. Srbel J, Dickey J, Lee D, Lowerison M (2010). Dry needle stimualton of myofascial trigger points evokes segmental anti-nociceptive effects. *Journal of Rehabilitation Medicine.; 42*(5): 463-468.
14. Unverzagt C, Berglund K, Thomas JJ. (2015) Dry Needling for Myofascial Trigger Point Pain: A Clinical Commentary. *Int J Sports Phys Ther.; 10*(3):402-18.