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Review Article

Physical Modalities for Wrist and Hand Tenosynovitis

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Abstract

Tenosynovitis of the wrist and hand such as De Quervain's disease, Dupuytren's contracture, and trigger finger are primarily caused by repetitive trauma to the wrist and hand. De Quervain's tenosynovitis is overuse of the abductor pollicis longus and extensor pollicis brevis due to grasping activities. Physical modalities like the use of paraffin bath, low-level laser therapy, ultrasound therapy and phonophoresis along with other conservative management have proved to be effective to improve overall function. Dupuytren's contracture is a fibrous disorder of the palm and its gold standard treatment is fasciotomy but recent evidence shows extracorporeal shock wave therapy (ESWT) as the most effective treatment of it. A trigger finger also called stenosing tenovaginitis is a condition in which the finger gets stuck in a bent position because of hypertrophy at tendon junction and an increase in pressure at the proximal A1 pulley. ESWT is effective in this as it reduces pain, severity, and functional impact of triggering. It is a big challenge to handle these conditions as little information is available apart from steroid injections and surgery. Physical modalities have been demonstrated in physical therapy, but their effects are never seen on hand and wrist pathologies. The purpose of this article is to provide information on the effectiveness of physical modalities for tenosynovitis of the wrist and hand. Physical modalities along with other conservation management relieve pain and improve functional status.

Keywords: De Quervain's tenosynovitis; Physical Modalities; Pain

Introduction

De Quervain's tenosynovitis

De Quervain's tenosynovitis is stenosing the painful state of the first dorsal compartment on the wrist.The pain is close to radial styloid generally present unilaterally. Due to micro-trauma to the abductor pollicis longus and the extensor pollicis brevis at extensor retinaculum exaggerated by grasping activities. Fibrous thickening of the tendon sheath to the radial styloid [1].

The prevalence of this condition is close to 0.5 percent for men and 1.3 percent for women with a higher prevalence among those between the ages of 30 and 55 [2].

Activities with rapid wrist movements like pinching, grasping, pushing, and pulling increase the risk. People with diabetes mellitus, rheumatoid arthritis, and pregnant women are at greater risk. The lifting of the baby in new mothers, frequent texting, sewing, knitting, typing, and household chores are more common causes of

De Quervain's disease. 70 percent of the patients were housewives in a study by Zafar., *et al.* [3]. Options for treating De Quervain's Tenosynovitis include Spica splints, corticosteroid injections, physical modalities, manual therapy, and surgery [4].

Dupuytren's contracture

Here we mention Dupuytren's contracture because it causes decreased range of motion in affected fingersand can lead to the development of tenosynovitis condition of the hand [5].

Dupuytren's contracture is defined as a benign fibrosing disorder that results in gradual thickening and shortening of the palmar fascia. The contracture mostly develops in the Metacarpophalangeal joint and proximal interphalangeal joint of the hand. The ring finger is mainly affected followed by the little finger and then the middle finger [6]. Dupuytren's disease is also accompanied by some rare fibrosing at the local site. E.g., in Garrod's nodules, there is fibrosing on the dorsal proximal interphalangeal joint. Fibrosing at the sole is known as Ledderhose disease and in Peyronie's disease, there is fibrosing of the dorsum of the penis. Dupuytren's usually happens among people of northern European origin and affected 4 percent to 6 percent of the white race. In one study, the occurrence of disease in the United States is 0.5 percent to11 percent. In another study, it is reported that the prevalence of the disease across the world was 0.6percent to 31.6 percent. 45 percent of people suffer from the bilateral condition and the right hand ismore affected if the unilateral condition develops. Dupuytren's contracture occurs primarily within males with ratios ranging from 2:1 to 10:1. Male has reported greater intensity of disease due to manifestation of androgen receptors in Dupuytren's fascia [7,8].

The patient who develops Dupuytren's contracture mostly has a positive family history and developed the disease 5 years before those without positive family history. Other risk factors comprise patients havingdiabetes mellitus, heavy drinkers, and patients taking antiepileptic drugs and smoking [8], hyperlipidemia,complex regional syndrome, major or minor trauma. The recent study also detected another potentialrisk factor. People who participated in occupation repeatedly exposed to hand-transmitted vibration. Rheumatoid arthritis seems to protect Dupuytren's contracture [8].

Phases of diseases

Dupuytren's contracture formation consists of three phases

- PROLIFERATIVE PHASE in which myofibroblast proliferate palmar fascia ad develops nodules. The patient complains of tenderness and pain due to compression of local nerves and nerve fiberpresent in aponeurosis
- The second phase is INVOLUTION PHASE in which the disease progress to the whole fascia and fingers and result in cord formation
- In the last phase, RESIDUAL PHASE contracture appears due to the tightness of the cord

Classification of disease

Iselin classifies the disease in 4 stages based on the location of the disease. (Table 1). Mikkelson classifiesthe disease according to the degree of contracture present at fingers and palms (Table2). Tubiana classification differentiate the stages of the disease based on total deformity plus flexion deformity at themetacarpophalangeal joint, proximal interphalangeal joint, and distal interphalangeal joint (Table 3) [7,8].

Stages	According to Iselin
Stage-I	Nodule formation in palm
Stage-II	Nodule formation in the palm and semi flexion at metacarpophalangeal joint
Stage-III	Nodule formation in the palm and semi flexion at metacarpophalangeal joint proximal interphalangeal joint
Stage-IV	Nodes are present in the palm and semi-flexion at the metacarpophalangeal joint, proximal interphalangeal joint, and hyperextension at the distal interphalangeal joint.

Table 1: Stages of DD according to Iselin.

Stages	According to Mikkelson
I. Stage	Presence of nodes and cords without contracture
II. Stage	Contracture ranges from 1°-45°
III. Stage	Contracture ranges from 45°-90 °
IV. Stage	Contracture ranges from 90°-135°
V. Stage	Contracture is greater than 135 °

Table 2: Stages of DD according to Mikkelson.

Stages	According to Tubiana Classification
Stage 0	No physiological findings
Stage N	Presence of palmar or digital nodules without flexion
Stage 1	Flexion deformity ranges from 0° to 45°
Stage 2	Flexion deformity ranges from 46° to 90°
Stage 3	Flexion deformity ranges from 91° to 135°
Stage 4	Flexion deformity is greater than 135°

Table 3: Classification of DD according to Tubiana.

Dupuytren's contracture is managed either by the surgical way which includes percutaneousaponeurotomy or open fasciotomy or minimally invasive procedure which include enzymatic collagenase injection such as *Clostridium Histolyticum* are used if the finger joint contracture is greater than 20° [10].

The recent study also suggests some conservative treatments like low-dose radiation therapy growth factors like N-acetylcysteine and angiotensin-converting enzyme inhibitors. They all are evident to limit the progression of the disease. In the nodular stage of disease, some anti-inflammatory and anti-mitotic drugs like tamoxifen are also effective [7].

ESWT is an efficient, non-surgical treatment used for many musculoskeletal conditions like plantar fasciitis and certain tendinopathy and also effective for chronic resulting from burns wounds and for scartissue release. Shock waves are sound waves and in ESWT short pulses of shockwaves with high pressure are targeted on local tissues to promote tissue healing, regeneration, and angiogenesis in localized tissue. Two modes of ESWT are currently used i.e., focused and radial. Radial shock waves are more effective than focused but they transmit less energy. Radial shock waves have a broader effect than focused waves. Radial shock wave probe diffuses the energy radially into the tissues while focused shock waves focused deeply on targeted tissues [5,10].

Trigger finger

Stenosing tenovaginitis, also known as trigger finger is defined by stucking of the finger during its movement, because of hypertrophy at the junction of the tendon with the tendon pulley. It restricts the normal forward and backward movement of the tendon under the pulley. It is believed that the disease is caused by elevation in the pressure at the proximal edge of the A1 pulley and disagreement between the diameter of the flexor tendon and its sheath at the metacarpal head. It is also said thatthe increment in the percentage of chondrocytes in the A1 pulley and fibrocartilage metaplasia is the reason for this disease [11,12].

Movement hindrance, pain, and edema may occur and it will contribute to the formation of nodules at the palmar side of the hand. The main cause of this disease is unknown but it is believed that repeated and minor trauma contributesto this disease. Other diseases that may contribute to this are diabetes mellitus (DM), collagen tissuedisease, rheumatoid arthritis, Dupuytren's disease, amyloidosis, mucopolysaccharide storage disease, congestive heart failure, genetic predisposition, hypothyroidism, de Quervain's disease, carpal tunnel syndrome and renal diseases [11,13].

Trigger finger is the most common flexor tendinopathy between the ages of 52-62 years and is more common in females. Thumb (33 percent in adults and 90 percent in children) and the fourth finger (also called the ring finger) are mostly involved. It is seen that the right hand is involved more than the lefthand and the dominant hand is more common than the non-dominant hand. The incidence of this pathology is more in rheumatoid arthritis and diabetic patient than in normal persons. Such patients mayhave disease in more than one finger [12].

Diagnosis is easy as the symptoms are very obvious like pain, swelling, morning stiffness. In the initial stages, this goes on its own, but if not treated, the finger may become permanently in a flexed position. Its treatment options can be split into conservative and surgical. The surgical option is valid when a patient doesn't respond to conservative treatment. Conservative treatments include NSAIDS, corticosteroid injections, extension splint, and certain exercises of stretching and mobilization [14].

ESWT (extracorporeal shock wave therapy) is the latest replacement to current management options. It is successful in symptomatic management. These are the sound waves that increase the pressure ofdesired tissue in a short period of nanoseconds [13].

Tenosynovitis and physical modalities

De Quervain's tenosynovitis

In a single-blinded study by Ilknur Aykurt Karlibel., *et al*. paraffin bath was applied on 51 subjects aged 18- 65 years, pain du-

ration nearly four weeks, pain about 4 on the VAS (Visual Analogue Scale) 1-10 score. The temperature of the paraffin bath was adjusted to 52 degrees Celsius and the hand was 10 times dipped in the bath and covered in a towel. The treatment was given in 10 sessions for 5 days a week for 20 minutes with splinting and exercises. Significant improvements in pain and functional status were observed in subjects who were given a paraffin bath compared to the Spica thumb splint and exercises alone [4].

In a study conducted by Darien., *et al.* 30 women between the ages of 25 and 35 with post-partum De Quervain's tenosynovitis were taken. Low-level laser therapy (wavelength 830nm, energy density 20J/cm2, power 30-40, beam diameter 4mm) was given to 15 women for 10 minutes with exercises for 4weeks, 3 times a week. Exercises for strengthening and stretching of extensor pollicis brevis and abductor pollicis longus for 30 minutes were performed then the patient is asked to wear a spica splint. The results were compared to the subjects treated using exercises alone. The pain was reduced in both groups but was 92.5 percent reduced in the Low-Level Laser Therapy group and 31.06 percent in the control group measured by the VAS scale [15].

One study by Kamalkanan., *et al.* found that using Low-Level Laser Therapy with Kinesio taping significantlyimproved the VAS scale and PRWE (Patient-Rated Wrist Evaluation) scores. The success rate was 80 percent against 30 percent in therapeutic ultrasound and exercises on 30 subjects over 2 weeks [2].

Ghada., *et al.* randomly assigned 40 women with post-natal De Quervain's disease, mostly housewives. Twenty women received five minutes of sodium diclofenac (10 mg) as a coupling medium with the continuous mode of ultrasound. The frequency of ultrasound was adjusted to 3 MHz and intensity was kept at 0.5w/cm2. The remaining 20 were treated with Kinesio taping. It took place three times a week for four weeks. The outcomes of the intervention showed that the DASH (Disabilities of the Arm, Shoulder, and Hand) score decreased by 38.71 percent with phonophoresis and by 34.67 percent in Kinesio taping demonstrating the effectiveness of phonophoresis [16].

Sharma., *et al*. divided 30 patients between the ages of 21 and 45 into two groups. One group received ultrasound (3 MHz frequency with aquasonic gel as coupling medium) and another low-level laser therapy (infrared, 830nm wavelength, 30-40 mw power, and beam diameter 4mm) for 14 days on alternate days.The VAS scale, grip strength, and Ritchie tenderness scale showed significant improvement with the two therapies. On average ultrasound therapy showed better grip strength and VAS results. An improvement on the VAS pain scale and tenderness with the application of ultrasound and low-level laser therapy showsa reduction in the diameter of the tendon sheath when viewed through diagnostic ultrasound. It increases movement, and it reduces pain. The increase in motion is due to the attenuation of inflammation and hence more healing. In addition, those that do not show a lot of improvement had thickened retinaculum [17].

Case reports of Dupuytren's contracture

In a case study conducted by Stefano Brunelli in 2020, a 79 years old man with having a past medical history of diabetes, hypertension, and prostatic hypertrophy was presented with the chief complaint of pain, flexion deformity of middle and ring finger, and functional impairment due to hand weakness from recent 4 years. Through goniometer flexion ranges are checked and patients have developed flexion contracture between 0°-45°, stage-I by Tubiana. The patient has undergone 4 weeks sessional treatment program using Radial ESWT with 1400 impulses and 12 Hz. A concave head probe with having a diameter of 9mm was used and waves are given for 2min. No orthotic device was used during the treatment era. Inthe first 2 sessions after 24 hours of therapy, patient symptoms worsen but the improvement in hand function was improved. After the 4th session, a reduction in nodules was reported and flexion deformity decreased to 15°. Functional movement like grasping was improved. Two scales were used to access the limitation of Dupuytren's contracture i.e., Disabilities of Arm Shoulder and Hand Questionnaire (DASH) and the Michigan Hand Outcome Questionnaire (MHQ). DASH has 30 as the minimum score and 150 as the maximum score. A low score indicates a high degree of independence. MHQ score ranges from 0 to 100 and a low score indicates a high degree of impairment. During the initial assessment, the patient DASH score was 32.1 and MHQ score was 54. After 4 weeks of sessional and 4 months of follow-up treatment, the DASH score was 10.7 and the MHQ score was 75.

In another case study conducted by Parisa Taheri in 2021, on a 64 years old farmer. He complained of flexion contracture on the 4th metacarpophalangeal joint of the right hand. The symptoms of pain and movement restriction were present for the past 8 years

Figure 1: Clinical evaluation before treatment.

Figure 2: After the 4th session ESWT.

but he recently observed the worsening of symptoms in his right hand. The patient neither has any positive family history of Dupuytren's disease nor any co-morbid condition. Extension restriction of 30° was measured by goniometer and there is a palpablenodule of 2-3mm in size at the base of the 4th metacarpophalangeal joint. DASH score of the patient was 24. The patient has been given treatment by the radial extracorporeal shock wave. 5000 shockwaves withthe pressure of 5 bars and frequency of 15 Hz were administered on the nodule and cord. After a 6-weeksession, ROM become normal and the DASH score of the patient was 18 [10].

Figure 1 Flexion contracture in a patient with Dupuytren's contracture before and after treatment with radial extracorporeal shock wave) [10].

In an article related to ESWT for Dupuytren's contracture published in January 2021, RCT was conducted on 52 patients of which 62 percent were males. All the patients with Tubiana stage N were included in RCT. The study group received focused ESWT at 2000 impulses 0.35mJ/m2 per week for a three-week session. The Control group received placebo treatment for the three-week session with focused SHAM ESWT with 2000 impulses 0.01J/m2 per week. Both groups follow up treatment after 6, 12, and 18 months.In the study group, there is a 53 percent reduction in pain after 12 months DASH score improved from 12 ± 18 to 10 ± 9. While in the control group receiving placebo treatment pain is increased by 48 percent after 3 months and the DASH scale was progressed from 6 ± 10 to 14 ± 13 as the Dupuytren's worsen [7].

Another study was conducted to observe the effect of physical modalities for Dupuytren's contracture 15 patients with the disease were treated with ESWT, 15 received Temperature Controlled high Energy adjustable multimode emission laser, 10 patients were received electron beam therapy, and 76 patients received radiofrequency. ESWT is found more useful and successful to treat Dupuytren's contracture [18].

Trigger finger

Mahbube Dogru did one study taking eighteen patients. This study includes only the experimental groupand there was no control group. Patients with trigger fingers were given 10 sessions two times a week forfive weeks of ESWT (2000 impulses, 2 bar, 10 Hz). And results were noticed including a range of motion, the strength of grip, and pinch strength before, after, and three months after the treatments [11].

In another study by A.T. Sugawara nine hundred patients were taken with musculoskeletal disorder and were applied ESWT for pain [19].

Another study was conducted by Babak Vahdatpour Fahimeh Momeni, in which they selected 19 patients with trigger fingers. They used quinnell and quick disabilities of the arm, shoulder, and hand (DASH) questionnaire to assess them before the intervention, after the intervention, and 6-8 weeks afterintervention. Each patient was given 3 sessions of extracorporeal shock wave therapy in

a week. For the analysis of data, they used a statistical package for the social science (spss) software and ANOVA for the detection of functional changes during treatment [12].

One another study took nineteen patients, of which 27.8 percent had carpal tunnel syndrome, 11.1 percent had diabetes, 16.7 percent had hypothyroidism, 27.8 percent had trigger finger in the middle finger and 50 percent had this in the thumb and 66.7 percent didn't receive any treatment. ESWT appliedand we come to the point that the severity of trigger finger reduced from 3.50 to 1.75 in a period of 18 weeks after intervention [12].

Discussion and Conclusion

The heat applied to a specific area causes an analgesic effect on the nerves, it also increases the production of peripheral endorphins and alleviates muscle spasms. Heat also enhances the viscoelastic properties of soft tissue. The heat relaxes the smooth muscles in the arterioles resulting in vasodilation and increasing blood flow. This condition of hyperemia wash away exudates and transudates [4].

The laser increases blood flow to the area where it is applied through vasodilatation. As inflammation diminishes, the nerves are free from irritation, which reduces pain. Low-Level Laser Therapy improves soft tissue healing by increasing collagen synthesis and angiogenesis [15].

Therapeutic ultrasound uses sound waves to promote tissue healing, pain relief and increase soft tissue extensibility [2].

Phonophoresis is the use of ultrasonic therapy to administer the drug transdermally. It is a non-invasive procedure for the local administration of drugs with an ultrasound frequency of 0. 75-3 MHz Continuous mode is more efficient than the pulsed mode for administering drugs [20].

ESWT is a more secure non-surgical treatment for curing and stopping the progression of the Dupuytren'scontracture as compared to the surgical approach because there is a high recurrence of disease after surgery. Collagenase injection and needle fasciotomy also have relapsing chances of 45 percent after 3 years. Gold standard treatment for Dupuytren's disease is a surgical approach in which affected tissue is removed and finger contractures are released but there are high chances of recurrence [6].

ESWT, radiotherapy, electron beam therapy, and targeted radiofrequency are effective non-surgical treatment options for Dupuytren's disease. ESWT is effective for decreasing the size of nodules and improving the functional activities of the hand. Radiofrequency is efficient for the termination of the advancement of the disease. Ultrasound therapy along with physical mobilization and stretching enhances the active extension of digits. A high-energy adjustable multi-mode emission laser is a new therapeutic option to treat Dupuytren's disease [18].

ESWT improves circulation and proliferation, speeds up the process of cell regeneration and tissue regeneration in the tendon. It is thought that increases the process of healing, has an effect on neovascularization, and decomposes the calcium. This mechanism is effective against the thickening of the flexor tendon and its sheath which is the reason behind the trigger finger [11].

Strong evidence suggests that pain is reduced which was measured by the visual analog scale (VAS). Painwas reduced in 63.4 per cent VAS = 2.90, 95 percent. It is also said that shock wave destroys and removes damaged tissue matrix. Also, the application of stem cell and growth factors and does synthesis and release of nitric oxide decreases inflammation [19,20].

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