Title:

Case Study: Treatment and Rehabilitation of an Avulsion Fracture at the Base of the 5th Metatarsal: Is an integrated approach the way forward?

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Abstract

Every healthcare professional aims to provide the very best of care for all patients. As a Physical Therapist in Ireland I am always on the lookout for new techniques and modalities that will benefit my patients. In following the principles of evidence and research informed practice it's vital that we are able to understand why and how different modalities work and it is equally important that we can provide a solid rationale for any modality that we may incorporate into everyday practice.

We often look towards other health care professions to examine whether modalities they employ can be integrated into our own practice. One such modality that has become an integral part of an integrated treatment approach at the Deerpark Clinic (www.deerparkclinic.ie) is Dry Needling Acupuncture as taught by Dr Yun Tao Ma. Text books authored by Dr Ma provide a solid rationale for pain management[1]and for sports and trauma rehabilitation [2] using Integrated Systemic Dry Needling (ISDN).

An athlete's return to competition depends on much more than what happens in the clinic. A well structured sports rehabilitation programme can ensure that they do so in the optimum time-frame and with a minimised risk of re-injury.

This case study examines an integrated approach to treatment and rehabilitation for the injured athlete. The integrated approach combined Integrated Systemic Dry Needling (ISDN), physical therapy modalities and a sports rehabilitation programme.

The patient was treated over a period of 14 weeks starting immediately following the initial injury until a successful return to play as a semi professional soccer player.

Readers should note that this is not a prescribed approach for all such cases but merely a description of what was found to be successful in this case.

Introduction

Rosenberg G.A et al (2000)[3] described three distinct fracture patterns that occur in the proximal fifth metatarsal.

1. Tuberosity avulsion fractures.
2. Acute Jones fractures.
3. Diaphyseal stress fractures.

Confusion over terminology has clouded the management of these fractures. Some clinicians use the term "Jones Fracture" to refer specifically to acute diaphyseal fractures. Others use it indiscriminately to describe all proximal fifth metatarsal fractures.

This case concerns an avulsion type fracture at the base of the fifth metatarsal resulting from a lateral ankle sprain where the peroneus brevis and the lateral plantar aponeurosis have torn away some bony tissue. The general protocol for treatment and rehabilitation of these types of injuries is similar despite a variety of actual diagnoses (Marder, R.A., Lian, G.J. (1997)[4]

Blood supply to the site of injury is slight; therefore complications such as non-union and delayed union can occur.

Clinical Application

A 25 year old soccer player presented with pain on and underneath the lateral aspect of his right foot, which was aggravated by weight bearing. The patient reported that he twisted his ankle (inversion sprain) the previous day during a soccer match (this is a typical mechanism of injury for an inversion ankle sprain). He felt "a sharp pain" on the outside of his ankle and was unable to continue playing.

Clinical Findings

Initial examination revealed tenderness on palpation at the base of the fifth metatarsal. The patient also felt pain when he inverted and dorsi-flexed his ankle.

Table: Range of Movement

	Active Range of Movement (AROM)	**Active Range of Movement (AROM) Right Foot**
Plantar Flexion	60°	60°
Dorsi Flexion	45°	30° with pain on the lateral ankle
Inversion	15°	10° with pain on the lateral ankle
Eversion	15°	15°
	Passive Range of Movement (PROM) Left Foot	**Passive Range of Movement (PROM) Right Foot**
Plantar Flexion	60°	60°
Dorsi Flexion	45°	30° with pain on the lateral ankle
Inversion	15°	10° with pain on the lateral ankle
Eversion	15°	15°

	Resisted Range of Movement (RROM) Left Foot	Resisted Range of Movement (RROM) Right Foot
Plantar Flexion	5/5	4/5 and painful on the lateral ankle
Dorsi Flexion	5/5	3/5 and painful on the lateral ankle
Inversion	5/5	3/5 and painful on the lateral ankle
Eversion	5/5	3/5 and painful on the lateral ankle

Diagnosis

A metatarsal fracture was suspected with this patient and he was referred back to his GP. The patient's GP arranged for him to see an orthopaedic surgeon who ordered an MRI scan. The MRI revealed a non-displaced tuberosity avulsion fracture of the fifth metatarsal. MRI is reported to be 100% sensitive and specific in identifying avulsion fractures, Walsh et al (1999b). [5]

Treatment

The patient's foot was placed in bulky soft dressing permitting partial weight bearing. Avulsion fractures of the proximal fifth metatarsal tuberosity can usually be managed with a soft dressing, Hatch RL et al (2007)[6].

He was instructed to avoid activities that would put the injury at risk and to seek physical therapy treatment and rehabilitation for the injury. The patient was concerned that he might not be able to return to play in the current season and that he might lose too much in terms of fitness and overall conditioning.

In its position stand on cardio-respiratory fitness the American College of Sports Medicine reported that although stopping training showed dramatic reductions in VO2 max and strength, reduced training showed only modest or no reduction for periods of 5-15 weeks, Pollock et al (1998a)[7]. The athlete was guided to perform a reduced training programme, avoiding activities that would put the injury at risk.

Effects of Immobilization

The patient had his foot partially immobilised in a bulky soft dressing for 6 weeks. The effect of immobilising the joint would include cell necrosis of the soft tissue structures around the joint Immobilization affects not only the immobilized joints but also the kinetic chain associated with those joints, Kibler W (1998a).[8]

Muscle Changes

Muscle changes as a result of immobilisation include, a decrease in muscle fibre size, atrophy of both type 1 and type 2 muscle fibres, decrease in size and number of mitochondria, reduction in the levels of ATP, ADP, CP and glycogen, decrease in protein synthesis

Articular Cartilage Changes

Articular cartilage changes include, decrease in proteoglycan synthesis, death of chondrocytes, softening of articular cartilage

Bone Changes

Bone changes include, decrease in bone density, decrease in osteoblastic, osteoclastic and osteocyte activity

See Andrews et al p18 (1998a)[9] for further descriptions of muscle changes, articular cartilage and bone changes..

Neural Changes

It has also been reported that the reduction in muscle function may also be influenced by neural changes following immobilization; Gondin et al (2004)[10].

The integrated treatment approach.

The integrated treatment approach consisted of dry needling acupuncture using the Integrated System Dry Needling (ISDN) approach described by Dr Yun Tao Ma. It represents a synthesis of the theories and techniques of Travell and Simons[11] and C. Chann Gunn[12] with other needling techniques and Classical Acupuncture.

Dry needling initiates an immune response from the biological systems including the nervous system, cardio-vascular, immune and endocrine systems to replace the damaged tissue with the same type of tissue within a few days. In addition to the local healing effect, the lesion created by the needle induces systemic effects to restore homeostasis through a number of reflex processes at different levels of the central nervous system.

ISDN treatment was administered twice weekly from the acute injury phase through until the athlete returned to play three months later. The focus for each of the two weekly ISDN treatments was as follows:

Weekly Session 1: ISDN treatment of Symptomatic Acupoints (SA's) and Para-vertebral Acupoints (PA's) plus physical therapy modalities.

Weekly Session 2: ISDN treatment of Homeostatic Acupoints (HA's).

Weekly Session 1: ISDN treatment of Symptomatic Acupoints (SA's) and Para-vertebral Acupoints (PA's) plus physical therapy modalities.

Tissue healing and pain management was managed during the early stages by ISDN treatment of Symptomatic Acupoints (SA's) or local points at the site of injury. SA's were selected in soft tissue structures adjoining the injury site included the base of the fifth metatarsal, the peroneus brevis tendon as well as further up in the muscle belly, the plantar fascia and the lateral ankle ligaments. Two to three needles per square centimetre were applied around the symptomatic local injury site.

Whenever health declines, some peripheral sensory nerves become sensitised, therefore, needling was applied to some HA's on the lower limb including:-

- H4 - Saphenous nerve
- H5 - Deep fibular (peroneal)
- H6 - Tibial
- H10 - Sural
- H17 - Lateral popliteal
- H24 - Common fibular (peroneal)

ISDN treatment of Para-vertebral Acupoints (PA's) was applied from L2-S2, especially at L4, L5 and S1. These points were selected to match the Symptomatic Acupoints (SA's) according to spinal segmentation. The aims of treating PA's were:-

1. to facilitate peripheral desensitisation of SA's and spinal desensitisation.
2. to relax the back muscles to remove stress from the roots of the spinal nerves
3. to balance the activities of the Autonomic Nervous System

Physical Therapy Modalities

Physical therapy modalities were selected according to presenting symptoms and the various stages of tissues healing.

During the acute inflammatory phase, the emphasis was on facilitating tissue healing whilst managing the inflammatory process. Immediately after the fracture a haematoma develops at the fracture site, signalling a cascade of cellular events including the release of growth factors such as TGF(beta) and PDGF, Bostrom et al (2000a)[13]. During the first 7 – 10 days of fracture healing, cartilage and new capillaries form and processes known as intra-menbranous and endochondral ossification begins, Frontera (2003c)[14]. According to Frontera during the proliferative and matrix production phase, the principles of treatment and rehabilitation are early motion, which aids cellular orientation and the prevention of adhesions, protection from mechanical overload, and strengthening exercises that allow a functional gait.

Following this process, woven bone is remodelled into stronger lamellar bone by the orchestrated action of osteoclast bone resorption and osteoblast bone formation, Bostrom et al

Active assisted ROM (AAROM) exercises are performed to assist early motion, Banders and Sanders p14 (2001a)[15].

Massage therapy has been shown to decrease the proliferation of inflammatory cytokines and to promote mitoichondrial cellular activity, thus facilitating tissue healing. Massage therapy around the joint but not directly on the site of the injury was used to facilitate the movement of oedema resulting from the inflammatory process. Myofascial release procedures include techniques developed and described by individuals such as Travell[16], Greenman[17] and others.

Cross friction techniques developed by John Cyriax[18] across lesioned ligaments and tendons create a numbing effect and localised hyperaemia to maintain structural mobility. Friction techniques were applied to facilitate tissue healing and the correct orientation of scar tissue.

Foot and ankle mobilisations were applied during each treatment. These have been shown to restore range of movement.[19]

Muscle energy techniques are effective for joint restrictions, muscular contractions, spasms and tightened/shortened muscles. Muscle energy procedures include techniques such as strain-counterstrain, positional release, facilitated stretching and resisted stretching.[20]

Weekly Session 2: ISDN treatment of Homeostatic Acupoints (HA's).

Homeostatic Acupoints were discovered by Dr H.C.Dung[21] and this advanced our understanding of the connection between homeostatic trigger points and the principle of central innervation of trigger points.

Evidence based research reveals that an injury produces both local symptoms and systemic dysfunction. It follows logically then that restoring homeostasis should form an important element of the treatment approach.

Homoestatic dry needling was conducted during the second weekly session every week for three months. The ISDN approach was used with the aim of maintaining homeostasis by balancing the nervous system through needling at selected Homeostatic Acupoints (HA's) .

The 24 primary Homeostatic Acupoints were needled during each HA session. Secondary and Tertiary points were needled on an as needed basis. This was found to be the case in the lower limb HA's on the injured side. As treatment progressed the number of tender HA's diminished as did the need to needle them.

Dr Ma reminds us that the efficacy of ISDN therapy depends on two factors:-

1. The level of self healing potential of the body.
2. The ability of the particular symptoms or diseases to heal.

The 16 point quantitative evaluation method was used to classify the patient into the ABCD grouping. At the very start of the treatment process, the patient was found to be in the B group (a total of 8 tender Homeostatic Acupoints (HA's) were palpated i.e. one at H1 (deep radial) plus two at H4 (saphenous) on the uninjured side, two at H1 plus three at H4 on the injured side) . The B grouping categorises the patient as a Good responder to ISDN treatment. Towards the late stages of treatment, the patient had progress back into the A group with only 4 tender HA's (one each at H1 and H4 on both sides). The A grouping categorises the patient as an Excellent Responder to ISDN treatment.s

Needle manipulation e.g. tortioning or pistoning was not applied during any of the treatment sessions.

The Sports Rehabilitation Programme

A rehabilitation programme was created for the injured athlete based on the American College of Sports Medicine (ACSM) position stand on resistance training, Kraemer et al (2002b)[22].

The aims of the rehabilitation programme included improving bone strength. This can be achieved by gradually increasing dynamic loading on the bone. Growing bone responds to exercise through significant additions of new bone in both cortical and trabecular sites and shows periosteal expansion and endeosteal enlargement thereby enhancing the strength of the bone. By increasing the loading, endocortical bone formation is also increased, Carter et al (1988)[23].

The rehabilitation programme for this patient consisted of a criteria based multi-stage programme, Bandy and Sanders, p362 (2001a)[24], Frontera W, p264 (2003a)[25] There were three phases as follows:-

- Phase 1: The Early Phase
- Phase 2: The Intermediate Phase
- Phase 3: The Late Phase including the Return to Function Phase

The patient was required to fulfil certain objective and functional criteria before advancing to the next phase of the programme. The rehabilitation programme addressed the problems of the injured foot and it also involved other elements of the kinetic chain including ankle, knee and hip and ultimately the whole body.

The following rehabilitation principles will be adhered to:-

- Establish goals
- Adopt a team approach with the patient, his GP, Consultant and other stakeholders.
- Facilitate early motion and strengthening
- Be aware that healing tissue may be over-stressed.
- Set specific objective criteria
- The rehabilitation programme was individualised to the athlete
- The rehabilitation programme followed was evidence informed.

Phase 1: The Early Phase

According to Frontera during the proliferative and matrix production phase, the principles of rehabilitation are early motion, which aids cellular orientation and the prevention of adhesions, protection of the graft from mechanical overload, and strengthening exercises that allow a functional gait.

Active assisted ROM (AAROM) exercises were performed to assist early motion.

Closed kinetic chain (CKC) exercises were introduced to encourage co-contraction of the muscles of the whole limb. Closed chain exercises are an integral part of an accelerated rehabilitation programme Kibler W (2000b)[26].

Exercises at this stage commenced with isometric strengthening progressing towards isotonic strengthening exercises.

The criteria for commencing the rehabilitation programme were as follows:-

- Removal of immobilisation device.
- No pain on partial weight bearing (PWB).

The goals for Phase 1 were:-

- To reduce pain and inflammation.
- To increase ROM up to but not beyond the restricted.
- To progress from non weight bearing exercises to partial weight bearing (PWB) exercises.
- To maintain rest of body fitness, Peterson and Renstrom (2002)[27].

Phase 2: The Intermediate Phase

The criteria for progressing to Phase 2 of the programme were full pain free passive ROM, minimum pain and good strength.

Goals for Phase 2

The goals of this phase were:-

- To progress towards full active ROM for all movements of the affected joint.
- To develope strength on the injured side up to 75% to 80% versus the uninjured side.
- To improve proprioception and co-ordination.
- To maintain and improve rest of body fitness.
- To increase muscular strength, neuromuscular control and muscular endurance.

Phase 3: The Late Phase

The exercises in this phase included high speed concentric strength exercises, eccentric strength exercises and plyometric exercises. The purpose was to link the strength and speed of movement to produce an explosive-reactive type of muscle response as described by Andrews J, et al p186 (1998d)[28].

Exercises in this phase were aimed at maintaining or improving muscular strength, power, endurance and the neuromuscular activity already achieved. This is also the stage when sport specific exercises were introduced.

The following were the criteria for progressing to Phase 3:-

- Full pain free ROM
- Full weight bearing (FWB).
- Strength on injured side = 75% to 80% versus the uninjured side.
- Good rest of body fitness.
- Good proprioception and neuromuscular control.

The goals of this phase were:-

- To regain full active, passive and resisted ROM.
- To progress towards 100% strength compared with the uninjured side.
- To regain maximal proprioception.
- To return to unrestricted activity.

Phase 3 also included functional training exercises for the athlete in preparation for returning to play/

The athlete had to display full pain free ROM, full pain free flexibility in available range, maximal muscle strength, power and endurance, maximal proprioception, maximal neuromuscular control, sufficient cardiovascular fitness for sport and he/she must be psychologically ready to return to sport.

The focus for the final part of Phase 3 was on functional progressions and sports specific exercises ref. Prentice W (2004)[29].

The injured athlete had to be anatomically healed and had to have completed all of the rehabilitation stages to be considered for a return to sport (Kibler et al 2000)[30].

Conclusions and Discussion

The integrated treatment and rehabilitation programme used for this patient was successful in returning him to his pre-injury status. The patient was out of his sport for 14 weeks. There were no major complications with the injury recovery process e.g. there no delayed bone union (as confirmed by MRI at eight weeks post injury).

This case study draws on research and evidence for a number of modalities, however. it is not a prescription for all such cases. Practitioners are urged to form their own opinions on what works best for patients based upon experience and research. The author is at relatively early stages of experience in the use of ISDN techniques albeit with good results.

The ISDN treatment plan consisted of two weekly sessions treating three distinct types of acupoints were needled:-

1. Symptomatic Acupoints (SA's) were selected to facilitate tissue healing and for pain management.
2. Para-vertebral Acupoints (PA's) to facilitate peripheral desensitisation of SA's and spinal desensitisation, to relax the back muscles to remove stress from the roots of the spinal nerves and to balance the activities of the Autonomic Nervous System
3. Homeostatic Acupoints (HA's) were selected to improve homeostasis because evidence based research reveals that an injury produces both local symptoms and systemic dysfunction.

Physical therapy modalities were utilised where they were indicated based upon the practitioners experience and the evidence base for various modalities.

The rehabilitation programme was based on the American College of Sports Medicine (ACSM) position stand on resistance training, Kraemer et al (2002b)[31]. While the ACSM position stand on resistance training is considered by many to be the "Holy Grail" on resistance training, Sports Therapists and others involved in sports rehabilitation should be aware that not everyone agrees with this stand. In a review, Winett R (2004)[32] suggested that the ACSM position stand did not follow many of the recognised guidelines for meta-analysis and that there was very little support for any of the purported claims or conclusions.

Based upon the outcome achieved with this case, it is suggested that an integrated approach to treatment and rehabilitation is the way forward for this type of injury. Further research is warranted to explore the most efficacious integrated approach for this and other injuries.

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