

Muscle Guarding - Post injury and Surgery

A combination of conservative modalities, their outcomes and psychosocial Impacts....

Abstract:

Middle aged male suffered a right foot Jones fracture 9+ years ago, which was subsequently secured with a screw. Despite surgery and off-loading he continued to have significant problems for a further 6 months.

A later MRI indicated 5 fractures had been sustained to the area, which the orthopaedic surgeon described as a highly unusual presentation, one he had not encountered before.

He underwent 2 further operations, eventually stabilising the structures and achieving healing.

Unfortunately, onset of CRPS and Muscle Guarding occurred in early recovery from the surgeries and, for 9 years, he has been walking with a foot held in fixed:

- moderate dorsiflexion
- forefoot supination
- ankle inversion
- with toes 1-5 having no ground contact when seated or walking



Permission to use images and x-ray's given.

Pre-accident he was a very fit, active and sporting individual. Subsequent to the accident he has gained weight, developed Diabetes type 2. Such is the continuing foot problem he was advised elective amputation some 7cms above the ankle, which he had declined. In part he declined having been advised there was a 30% risk any prosthesis would fail arising from diabetes complications. More recently he reconsidered and the option was much more to the front of his mind.

He attended here with a left foot cuboid concern which, despite trying, we were unable to fully address with a manual therapy approach, there being degeneration to the joint and subsequently has had steroid injections for it. He returned with a view to exploring manual therapy options for his right foot. Techniques selected were neurospecific foot mobilisation (NSM), combined with Fascial Manipulation-Stecco Method (FMs) and deliberately simple functional exercise. The outcome over 3 treatment sessions was as positive as it could be, given the circumstances.

Subjective

For 9+ years he has walked with the right foot sustained (“fixed”) in moderate dorsiflexion, ankle inversion, with toes retracted and a markedly inhibited gait. Indoors he wears a trainer with AFO, heavily cushioned to protect metatarsals 4 and 5. The cushioning has to be replaced regularly due to breakdown from the pressure of the metatarsal heads. Outdoors an aircast boot is worn to protect his foot and ankle from being vulnerable to further incidents or knocked by others. This is a particular concern for him as, reportedly, the surgeon advised if anything else happened to the foot they could not do any more for it and amputation is likely. The foot regularly discolours and “blows up” when it has been stressed. He is in constant pain.



Observations - Right

1 Passive Assessment

Arthrokinematics

- Passive reduction of toes 2 and 3 was minimally achievable but they regressed immediately.
- Passive reduction of the hallux was similar.
- The ankle inversion and dorsiflexion positions of the foot cannot be passively reduced at all.
- Metatarsal heads 4 and 5 are rigid alongside each other in what seems a plantarflexed position. However, it is metatarsals 1-3 that are elevated via the muscle guarding.
- It is not possible to passively dorsiflex or plantarflex metatarsals 4 and 5 alongside each other, nor move both simultaneously. Any attempt reveals a hard end feel, a likely consequence of stabilisation through the surgery ([see x-ray page 4](#)).
- Additionally, there is complete lack of passive dorsiflexion and plantarflexion mobility between metatarsals 1-3 alongside each other, none of which can be reduced passively from their elevated retracted state. By contrast to metatarsal 4-5, any attempt to reduce them indicates a firm, leathery feel. There is no surgical reason for this fixation and may be consequent to muscle guarding.
- The elevated position of mets 1-3, combined with fixed immovable positioning of mets 4 and 5, expose the plantar metatarsal heads 4-5 to marked and protracted dorsiflexion ground reaction force moments. Additional reduction of functional mobility throughout the rest of the foot likely contributes to the gross plantar callus formation on metatarsal 4-5.
- Abduction, adduction, inversion, eversion, dorsiflexion or plantarflexion of segments of the medial column is not passively achievable. Nor are any of these passive motions achievable with the foot as a whole.
- Articular glide of the talocrural joint (AP and PA) is not possible, again reminiscent of soft tissue contracture.
- It was not possible to dorsiflex or plantarflex, abduct or adduct, invert or evert the ankle from its fixed position in Non-Weight Bearing (NWB).
- Articular glide of the subtalar joint in an AP and PA direction was not possible, nor could it be everted passively.

Tissues

- The right foot has extremely large plantar callous to the 4th and 5th metatarsal head area. It is vulnerable and reportedly breaks down if not managed by his wife with a file and also by podiatrists. He receives good podiatric care.
- There are no other tissue concerns elsewhere and, surprisingly, given the continued lateral loading there is no callus present to the lateral heel on presenting here.
- He has highly sensitised tissue down the lateral and dorsal aspects of the foot, partly where scar tissue is and also arising from his CRPS.

2 Functional Assessment

Stance

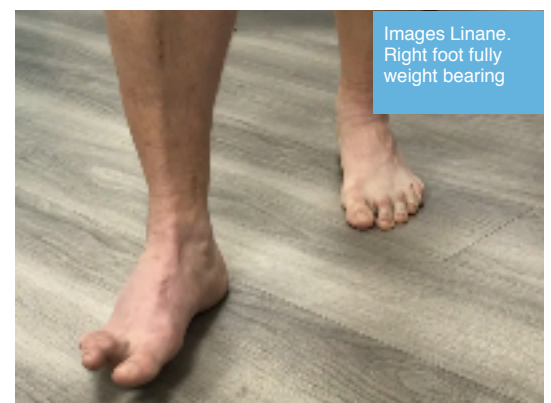
- Right leg and foot are slightly externally rotated but not significantly different to the left.
- Pain and sense of instability to the right foot in weight bearing causes a compensatory drift to and heavy load bearing upon the left limb.
- Loading of the right limb is all lateral with inverted, dorsiflexed foot position.
- Toes 2-5 quite retracted and hallux less so, but not in ground contact.
- Mets 4 and 5 appear plantarflexed and are the only load bearing area of the forefoot.
- There is effectively little difference in the foot position between weightbearing and non-weightbearing.



Images: Linane

Gait - Right

- This was highly unusual with obvious antalgic limp.
- Completely a-propulsive.
- No digital purchase.
- No frontal, transverse or sagittal plane motion at any point, anywhere within the foot or ankle.
- Almost no knee flexion.
- Leg slightly externally rotated.
- All loading is upon the lateral aspect of the foot.
- Much reduced swing phase on the left.
- A stick is normally used in gait even with AFO or boot.
- He is familiar with this gait and adapted to it well but it is clearly cumbersome and life limiting in terms of any activity.



Images Linane.
Right foot fully
weight bearing

Previous Interventions

Injury

- X-ray determined Jones fracture and surgery undertaken. (Surgery for Jones fracture: https://www.youtube.com/watch?time_continue=9&v=Wt710sZmSME)
- No significant improvement in over 6 months.
- MRI revealed a total of 5 fractures to the area.
- He subsequently underwent 2 further operations to his foot, which involved plates and screws, 2 of which have since broken (see x-rays below)
- Physiotherapy was supplied.
- Injection therapy.

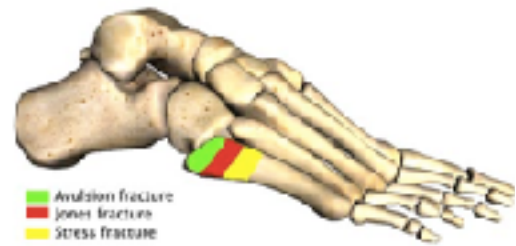


Image: New York Foot and Ankle Institute



Pain - mainly right.

- Over this early period he was diagnosed with Complex Regional Pain Syndrome (1,2,3) acquired a Muscle Guarding (4) problem to the foot and ankle and, more recently, tarsal tunnel syndrome to the left foot was diagnosed. This latter has responded to 2 steroid injections.
- He reports 10 injections, variously steroid and alcohol, into the right foot, ankle and leg, to manage his pain and guarding, none of which have been overly successful. Similarly nerve block injections have been unsuccessful.
- Various pain management strategies have been employed.
- A further co-morbidity of diabetes arose.
- Advised on an elective amputation some 7 cms above the ankle but also advised of a significant risk of potential prosthesis failure resulting from his diabetes.
- His foot undergoes various colour changes which seems to be a part of his CRPS experience and will enlarge a lot when irritated.

Impact

- Previously a highly active and sporting man the injury and consequent changes have resulted in a severely life limiting condition.
- He has anxiety regards any other injury that might happen to his right limb and wears a knee high protective boot when out and AFO on other occasions, which is heavily padded.

Attitude

- In spite of all the above he remains a determined individual, hoping to hold onto his foot as long as possible, and does not let the pain or disability rule his life. Recently though he is seriously considering amputation.
- On the psychosocial aspect, he acknowledges his social sphere has become limited due to his fear of further foot injury, so he avoids crowds or environments where other peoples enthusiasms may lead them to being accidentally careless around him.

Diagnosis

Based on reported history, in regards foot posture and function, I concurred with an earlier diagnosis of muscle guarding.

From previous experience in treating similar conditions the presentation did not match muscle spasm and the patient did not present with any of the likely contributors to prolonged muscle spasm such as:

- Amyotrophic lateral sclerosis (ALS or Lou Gehrig's disease)
- Arterial occlusive disease
- Chemical poisoning
- Demylinating disorders (e.g. MS)
- Electrolyte imbalance (hypocalcemia, hypomagnesemia)
- Fasciculation
- Infectious diseases (.e.g. polio, tetanus)
- Medication usage (e.g.diuretics, corticosteroids, Estrogens)
- Rare metabolic diseases of the muscle
- Respiratory alkalosis
- Spinal injury or disease

Additional matters

In terms of pain then a previous diagnosis of Complex Regional Pain Syndrome (CRPS) had been given. Certainly this can accompany muscle guarding.

Care Pathway

Essential Concerns

i) An important component to the care pathway was recognising the psychosocial aspects. Without going into details, significant emotional turmoils had been part of rehabilitation experiences for him. These had to be navigated between us in our conversations. Every endeavour was made to “normalise” the approach as being a simple conservative intervention, that had a biological plausibility, though limitations of evidence, but one that had not been explored with him and which came with no promises. Care as to use of descriptive and explanatory language was important (38).

ii) An agreed framework of approach was needed. In discussion regards intervention / interaction options I advised the use of neurospecific foot mobilisation and fascial manipulation - Stecco Method and functional exercise. The reasons for this were explained and he wanted to explore and try this approach.

Essential Framework.

Concerns a) *Pre-Treatment*: On a practical level, we agreed to assess and work proximal to and away from the site of injury and hypersensitivity. If we managed to gain positive change then at a further session we might work on appropriate structures closer to the site of sensitivity. Dependent upon review of the impact of the first session outcomes. He would be the guide as to tolerance levels throughout.

b) *Post-Treatment*: Should a positive outcome occur at session one we also agreed he continue to wear the AFO and/or aircast boot as per his usual practice when out, to minimise external risk factors. This was important to him. For me this was also important to preserve the existing structures (ligaments, tendons, muscles and bones) that would now undergo a loading level absent for so long. Such loading was to be limited to certain controlled environments and only two functional movements types ([see discussion page 14](#)).

iii) Given the unpredictability of his foot's responses, we discussed if he had concerns treatment might generate a reaction, even working away from the injury and hypersensitive sites. He commented that managing such reactions are a daily occurrence so it would be simply a further "managing" situation.

Verbal consent to treat was provided.

Aims and Methods Fascial Manipulation - Stecco Method (FMs) and neurospecific foot mobilisation (NSM) are intended, in part, to engage with neurophysiological potential to obtain a response from stimulation. It is posited there can be both localised and more global changes in mechanics of tissue function, joint function, proprioceptive awareness and changes in chemistry. ([see discussion](#)).

The treatment intent is to engage with these systems in a manner that evokes a positive efferent signalling in hope of subsequent reduction of increased tone in muscle, to improve mechanical function of joint structures (QOM and ROM) and restore capacity of the layers of the aponeurotic fascia to slide upon each other. ([see discussion](#))

The methodology of approach for the first session would be guided by assessment outcomes and patient wishes. It was likely to employ deep fascia manipulation at specific points in the thigh, leg and foot. If we gained positive changes to the ankle and foot position we would then employ neurospecific foot mobs to the 1st ray only. All these are away from or proximal to the affected site. We would also hope to minimise reaction. Further sessions would be guided primarily by outcomes on review and patient wishes.

Treatment Session 1

This was a total of 1 hour 30 minutes and included the above conversations, the FMs treatment and NSM to key foot joints. In total, hands on treatment time lasted around 45 minutes.

Fascial manipulation generally involves a combination of movement tests, accompanied by palpation tests of specific points within the limb and in each movement plane. It is theorised these points represent key locations, centres of coordination within a myofascial unit (28) within deep fascia, involved in coordination of relevant muscle function (see discussion).

As functional movement screening was not possible it was necessary to fall back on the understanding that immobilisation can affect the layers of deep fascia's capacity to slide on each other. Immobilisation had been present for 9 years. To that extent only palpation assessment could be undertaken. A number of sites within the whole low limb demonstrated positive points in different planes (see below).

A concern was not to treat too many points or too many planes in one session. The relevant points selected for treatment were these (see below and diagram).

Fascial Manipulation points identified (red dots)

Me-ge

Medial Genu. This relates to a proposed aponeurotic fascia point that coordinates muscles involved in frontal plane movement of the knee. Very much an orthogonal role. *It lies over: Gracilis*

Me-ta

Medial Talus. This relates to a proposed aponeurotic fascia point that coordinates muscles involved in frontal plane movement of the ankle. Very much an orthogonal role. *It lies over: medial belly of gastrocnemius in the myotendinous passage.*

Re-me-pe 1&3

Retro Medial Pes. This relates to where fibres of the deep fascia, from two planes, are oriented so as to converge and merge on the medial calcaneum (demonstrated by cadaver work). Effectively, these aponeurotic fascia fibres from two movement planes converge on 3 specific point on the medial calcaneum. *In this instance it was points 1 (between medial malleolus and tendoachilles) and 3 (immediately inferior to the medial malleolus)*

The level of tenderness varied between the points, running in a descending order from thigh to foot. This helped inform prioritisation of points to treat. Other fascial points that were positive for palpation testing would be addressed a further time, if outcomes are positive and if required.



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Image: Luomala (7). Red dots mine.

Fascial Manipulation Treatment: This can be uncomfortable or painful at the very outset but quickly reduces from this. Reduction of discomfort, together with a change in sensation in the tissue being worked on by the practitioner, are posited as indicators for positive changes. Patients sometimes experience a radiating sensation to other areas of the body.

- Patient side lying on his right and the right knee flexed slightly, FMs was applied, starting with the Me-ge. He reported sharp discomfort but at a tolerable level. He also reported a radiating sensation travelling down the leg and “into” the foot. As this area became far less tender and the stiffness of the fascial tissue more pliable we moved on to the next point.
- The Me-ta was treated. Of note is that this spot was now much less tender than when tested and yielded more quickly than the Me-ge. Again he reported a radiating sensation, though reduced. The ankle appeared less stiff at this point, slowly reducing the inversion angle.
- Both fascial points were assessed again and the localised tissue appeared far less stiff and much less tender. I asked permission to begin treatment on the medial calcaneum area (Re-me-pe 1 and 3) and this was given.
- As FMs was applied to Re-me-pe1, he reported a referred sensation around the whole calcaneum. Physically, at this point, the whole ankle felt to loosen further.
- I then did Re-me-pe 3 during which the whole ankle finally fully de-rotated from its inverted dorsiflexed position.
- With this sequence completed for now and with the ankle position changed, I asked him to lie on his back with a view to using the NSM to the foot.
- Before commencing on the foot I again asked his permission to continue. This was given.

Outcome from Fascia treatment:

The ankle was fully de-rotated from its inverted / dorsiflexed position but the hallux and lesser digits remained retracted and very stiff and could not be reduced passively.

Neurospecific Foot Mobs (NSM)

- NSM was applied to the first ray joints (talonav, navMcune1, Mcune1stmet), in a segmental way, working proximal to distal in all planes. Once completed we then continued the NSM in the central and lateral cuneiform areas.

Outcome From NSM

Supine, there was an immediate reduction of lesser toe retraction, that is, they relaxed downwards and were less stiff to palpation. I then helped him sit up so he could place his feet upon the ground.

Seated, with his feet upon the ground he became aware for the first time of the change in foot position and posture.

Additionally, after a poignant period of quietness, he used his stick and undertook a deliberately brief, tentative few steps in the new foot position.

Pre-treatment and immediate Post Treatment



First steps immediate post treatment

Image 1. This is his first forward placement of foot to full ground contact. It is a deliberate one with a very stiff foot,



Image 2. Single leg support with the foot flat to floor as contralateral leg undergoes swing phase. He is supported by use of his walking stick on the left side.



Image 3. The right limb undergoes swing phase with a de-rotated ankle for the first time in 9 years. Again the foot is stiff and exhibits no motion within itself. Toes do come down to full contact on placement.



Maintaining Gains

By way of wanting to maintain the gains but preserve existing structures that have not functioned in 9 years we invoked the framework. He was to continue wearing all bracing as per usual but in the house I asked him to undertake 2 functional tasks and asked his wife to ensure he did. These would be done over a protracted amount of time as neither of us had availability for an early follow-up appointment. Additionally I was concerned to stabilise the gains rather than rush in and make further alterations.

- Task 1, when seated at night, with no bracing, he ensures he keeps his foot flat to the floor and undertakes as much toe flexion and extension as possible.
- Task 2, Weight bearing, stocking feet, and supported by the back of a chair, both feet flat to the ground he is to undertake shallow knee bends, just enough to create a small level of flexion and extension at the talocrural joint. As time progresses and provided no pain or instability he could increase the depth of knee bends, but not to go deep.

These were demonstrated, the patient then demonstrated them to me and his wife observed how it should be done.

Although there would be a gap between us meeting I asked him to contact me with any concerns at any time. I also emailed him during this period to ensure things were going okay.

Session 2 Review

Due to personal circumstances it was 6 weeks before this follow-up could occur.

He reported:

- The first night and subsequent day saw his foot “balloon” and be painful. This did not concern him as it is a common reaction post any treatment to the foot, including acupuncture. By the following day this had reduced considerably. He considered there had been no need for him to contact me.
- He had continued the home exercises.
- He feels there is marked improvement in the ankle movement in the squats and his toes feel like they are gripping the ground more. He has walked without protection of the boot or AFO around the house and it feels to get easier with time.
- He has had a couple of falls since the last session, but this is not an uncommon experience anyway, so was not concerned.

Observation.

The most obvious visual cues were:

- Capacity to more readily and comfortably bear weight on the right foot
- Recovery of some further foot and ankle function in gait, when not in a boot or AFO or shoe.
- Complete resolution of plantar met callus to 4 and 5, much to my surprise.

Non-weight bearing motion

- His active ROM and QOM motion had markedly improved at the TCJ in all planes (see images below).
- Flexion and extension of the toes had markedly improved.

Weight bearing motion

- His weightbearing movement indicated the initial frontal plane positional changes in stance and gait had sustained.
- Gains in range and quality of movement at the TCJ, in the sagittal plane, had considerably improved in terms of squat ROM and QOM.

- However, this had not transferred into any reasonable sagittal, frontal and transverse plane motion during contact phase of gait, which remained unconfident.
- Additionally, the foot as a whole remained very stiff throughout the gait cycle.

Overall, he was delighted with the outcome and that it had sustained and was not expecting much else to change.



Session 2 **New Passive Assessment**

Foot.

- Although the earlier NSMs had brought some positive initial change, there was still marked stiffness within the foot, including restricted adduction to the individual talonav and navMcune joints. It would be appropriate to undertake these again but we could do this more comprehensively now.
- The relationship of metatarsal heads 1-2, 2-3 remained quite stiff in terms of superior and inferior glide along side each other. That is, none of them were readily moveable passively. The end feel here was now more soft though, indicative of tissue restriction changes from previous assessment.
- Similarly metatarsal heads 1-3 did not move inferiorly against mets 4 and 5. Again this was a softer end feel indicative of soft tissue restriction changes.
- By contrast, metatarsals 4 and 5 were immovable alongside each other, with a solid hard end feel, consistent with the plating being there.

Ankle

- ROM was much reduced in transverse and frontal planes when compared with the left. Sagittal plane ROM and QOM were relatively fine.

New Active assessment.

- Attempts by him to pronate the foot with simultaneous internal rotation of the ankle were extremely difficult and any motion was minimal. Similarly little midtarsal joint motion was achieved.

These findings were explained together with the work to be done. He was agreeable to this and acknowledged there may be a similar post treatment reaction flare.

**Treatment
Part 1.**

Passive Treatment

- Segmental NSM to the medial column plus additional superior and inferior glide to the talonavicular joint, navicular medial cuneiform joint and medial cuneiform base of the 1st metatarsal joint.
- Superior glide mobilisation to the central cuneiform and NSMs applied to the same area and area of the lateral cuneiform.

Passive Outcome

- *Improved dorsiflexion / plantarflexion of the 1st met against the second met.*
- *Earlier observed restricted adduction to the individual talonav and navMcunei joints was resolved with adduction there now being available now.*
- *Restoration of frontal plane motion throughout the midfoot.*

Active outcome

Pronation capacity had improved but the ankle still felt tight for him and looked limited, compared to the left.

However, he reported his foot as feeling to be much more in ground contact.

Additional passive treatment

Grade 3-4 Maitland ankle mobilisation of posterior to anterior glides to the subtalar joint

Grade 3-4 transverse rotation mobilisation to the talocrural and subtalar joints

Grade 3-4 distraction of the talocrural joint with simultaneous dorsiflexion and plantarflexion and transverse rotation of the talus within the mortice

Outcome

- *Improved pronation of the foot and internal rotation of the ankle in stance.*
- *He remarked he felt more motion available in gait.*

**Treatment
Part 2.**

Gait:

It had already been observed that prior to this last intervention there was an absence of heel/toe action in gait. The potential for this to change had arisen from the ankle and foot work and it was important to engrain any likely neurophysiological gains from this session through functional movement and exercise.

This was to be a further simple exercise added into the current one.

Treatment:

- I demonstrated heel contact, foot flat and propulsive phases that give us heel/toe action.
- Together we then practiced this on the right foot, with him holding onto the levelled out plinth. It took a little while to isolate the movements but it did occur.
- We then attempted this without holding onto the plinth and without his stick (which he has used less frequently anyway).

Outcome:

- *He began faltering heel/toe action, independent of support.*
- *This activity was to be added to the improving squat exercise at home, utilising support where he felt he needed it.*

Session 3 **Review** (again some weeks later)

- He reported all gains have remained and very much improved since the last session.
- There had been no adverse reaction and has managed to continue with both exercises but continues to wear the boot when in the street.
- Importantly, his confidence levels and ability to do things have increased considerably, to the point where he attended YOGA last week for the first time, albeit keeping his boot on.
- We discussed the positive biopsychosocial changes he has undergone, acknowledged that currently it is preferred for him to remain in the boot in the street.
- With all these changes quite localised to the foot and ankle I advised I wanted to return to looking at the low limb more fully again, particularly the fascia element.

Observations

- The gait remains remarkably improved with full return of appropriate contact phases of gait.
- I do not consider he will gain any further frontal plane movement in the foot or ankle, due to the imposed limitations of stabilising surgery.
- Fascia assessments were undertaken to the thigh and leg (palpation only as for the safety reasons).
- Most previously treated medial fascia points remained improved, with exception of Me-ge, which was slightly sensitive.
- The only other points that were positive for densification and treatment were: La-ge; Ex-ta.

Treatment

Whilst it is not wholly within the guidelines for Fascial work we agreed to treat the lateral fascia points. I advised him that in part this was to complete medial and lateral points, which is within guidelines but could not be done at the first session. Additionally, the Ex-ta point may well help with rotational elements of gait and possibly further contribute to improving proprioception.

Fascial Manipulation-Stecco Method was undertaken on La-ge and Ex-ta.

Whilst some referral sensations were reported and pain reduced with treatment he was agreeable to this and that we can only await possible outcomes later. Me-ge tenderness reassessed and was resolved.

Final Outcome

After a total of 3 treatment sessions over 11 weeks and in conjunction with simple functional exercise and discussions of a psychosocial nature (not discussed in this reflection on purpose), he reported the following in the last session:

- Very pleased and satisfied and somewhat overwhelmed with the changes.
- Sense of recovery of social life and well-being
- He felt he once again owned his foot and it was no longer a defunct unwanted appendage.

My observations were:

- Restoration of a significantly inhibited limb, likely arising from muscle guarding, to near full function, accepting the inherent limitations that cannot be altered.
- That the treatments employed were intended for this, addressing both biomechanical function and neurophysiological factors. *(Whilst similar outcomes have been achieved with others before, and subsequent positive outcomes have been the hoped for changes. But we cannot claim it was consequent to the treatment.)*
- A much happier person left on the third session and whilst the limb function had improved and although there is initially no obvious change in CRPS, there is a significant change in his biopsychosocial status.

Final Follow-up

On a 3 month email follow-up, post last treatment session, he reports all gains have remained in place and things are positive. In particular the amputation has now been very much put on the “back burner”. He particular references the marked difference for him mentally as well as physically.

Discussion

1. Risk Factors - Reasons for Continued use of the Aircast boot and AFO.

Aside from the patients genuine, understandable concerns to continue with their use, there were also clear clinical reasons not to remove them from the care pathway, simply because his foot posture had changed.

a) The change in foot posture was significant but this is not to be equated with restoration of the whole limb/foot towards healthy / normal function.

b) **Osteopenia** from immobilisation or much reduced mobility: This has relevance on many levels, from space flight (9) to injury induced situations (10), stroke victims (11) and may be further complicated for post menopausal individuals (10). Fortunately there are indications that disuse induced osteopenia has potential for reversal (9), though the research for single limb situations is apparently scant (9).

c) **Muscle atrophy risk.** Intrinsic foot muscles, in the healthy foot, are suggested to aid in medial arch maintenance and help in postural control in stance phases. They may also aid in controlling arch deformation in the gait cycle (12), something this foot has not experienced in a long time. Although weight bearing, much of this was on the lateral column of the foot in an aircast boot or and AFO splint in a trainer. Therefore no real weightbearing had occurred through the metatarsals 1-3 or toes 1-5 for 9 years. It is also questionable if the laterally loaded foot even worked properly in terms of intrinsic muscle function.

d) **Impact of diabetes.** Risk to intrinsic muscle health status and function can occur with diabetes, particularly in the presence of diabetes induced neuropathy. Clawing of toes is associated (13) and changes in the metatarsal angle which may contribute to ulceration (15) are associated with it. However, there is some suggestion that toe clawing may not be solely linked to diabetic neuropathy (14). Muscle tissue volume may also change, becoming invested with fatty tissue instead and certainly in the leg (16) it appears to leave the muscle vulnerable and with reduced strength and power.

The potential for tissue stress overload to the intrinsics post treatment, the plantar fascia and bone structures needed to be considered in any plan. Hence the exercise approach selected.

2 Exercise

Selection of simple exercise was purposeful.

- a) From an arthrokinematic perspective there were two major joints (talocrural and knee) and many small foot joints that had not functioned fully for 9 years. The same could be said for the hip but to a lesser extent. This could have impacted upon the quality of the osseous architecture, possibly on cartilage quality and quality of synovial fluid within the joints. The exercise provided allows for repeated, incremental knee flexion / extension, ankle dorsiflexion / plantarflexion, gradual exposure to an incremental increase of internal and external dorsiflexion and plantarflexion moments on the joints, bones and tissues of the foot and leg. This approach may allow for gradual increases of triplanar motion experience of the limb.
- b) There is a not unreasonable assumption that introducing gentle simple exercise of a minimal nature would be favourable to acclimatising him to changes in proprioceptive awareness.

All the above were undertaken in the context of his home and he was in control of the levels of increase of flexion and moving onto limited walking barefoot, as and when he began to feel confident. The use of the aircast boot / AFO within the house also meant the limb and tissues were not over exposed to such loading. Arguably this was over-precautionary but safety was priority as was building of his confidence of weightbearing on the limb

3 Modalities selected.

With regards to actual modalities selected there was a deliberate order: Fascial Manipulation-Stecco Method (FMs); Neurospecific Foot Mobilisation (NSM); Functional Exercise (FE).

a) Why utilise Fascial Manipulation-Stecco Method?

Historically, deep aponeurotic fascia was not considered a significant contributor to functional anatomy, injury or pathology, the tissue being removed to allow access to what has been considered the more significant structures of muscle, ligament or tendon (17). This view has undergone significant changes and study of fascia, alongside study of its potential role in pathology, underwent exponential growth between 2000 and 2010 (18) and continues to do so.

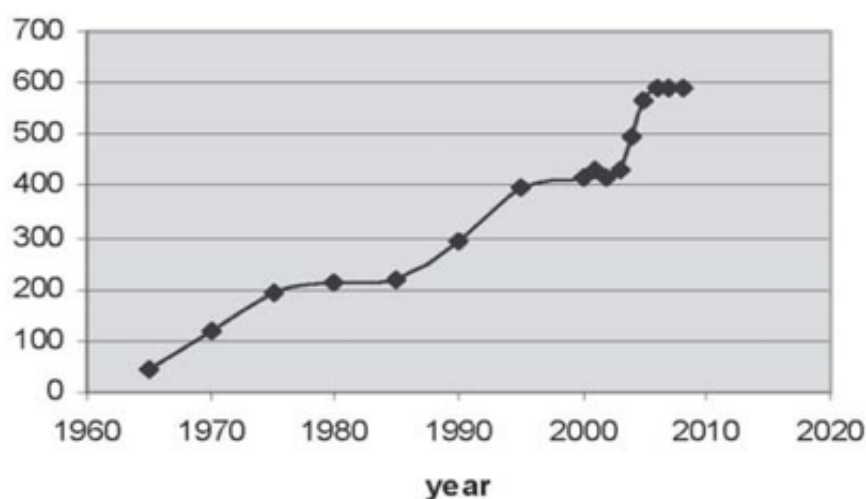


FIG. 1. Number of Medline-indexed publications each year with the term "fascia" in the title, abstract, or subject heading.

Today fascia is discussed in terms of its possible roles in force transmission (19,20), immunology (26,39), proprioception (17,22), pain (23) and biomechanical function (24) amongst other things. Current scientific studies opening up this area for detailed analysis.

Whilst fascia is often discussed and proposed in such terms we need to recognise this can be a clinical interpretation and application of understanding of unfolding anatomy insights, with the need for research through trials to indicate if this is along the right lines or not. Something rightly highlighted both by those with no clinical investment (25) and those who have clinical investment in fascia use (26,27).

What is certain is an increased understanding of the composition of the varied fascial tissues, the nature of its connectivity to other body structures, its histology and neurology and proposed functional roles are not things we can ignore.

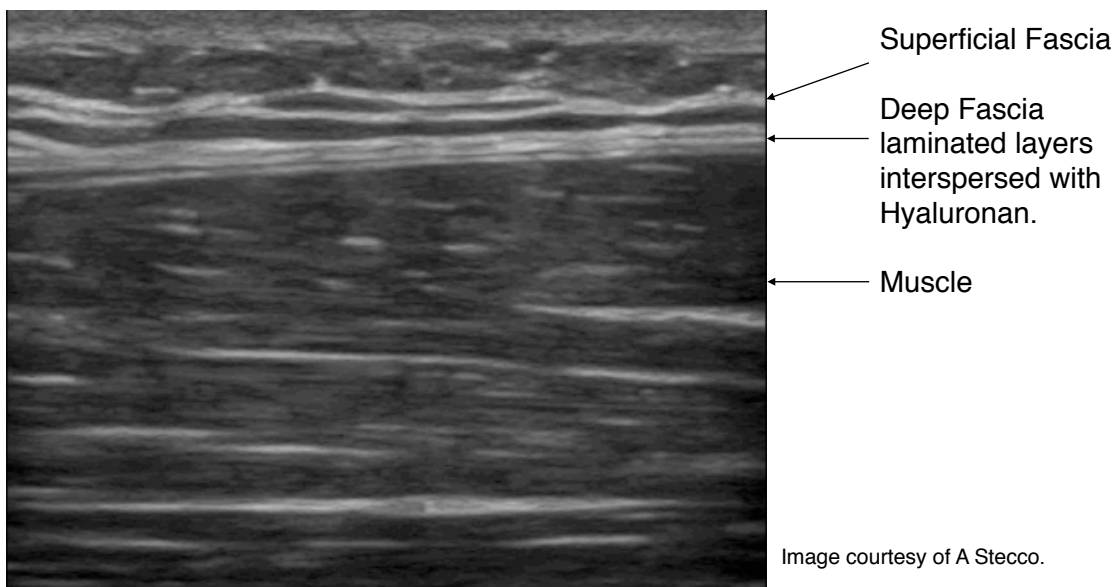
b) Similarly there are a plethora of fascia techniques to avail ourselves of, examples include Anatomy Trains, Active Release Technique, Foam Rolling, Fascial Manipulation- Stecco Method, to name just some.

Selection of any fascia intervention therefore is selecting, as yet, an incomplete but evolving model.

4 Stecco model

This approach appeals due to its roots in anatomical understanding (based on fresh unembalmed cadaver studies), its perception of the fascia as a biomechanical functioning tissue and its endeavours to understand anatomically, mechanically, histologically and neurologically the possible mechanism of the models action (24).

Interestingly, whilst titled “Fascial manipulation”, central to the model of pathological changes is not the tissue per se (which we can alter very little) but the contents within it, more specifically, Hyaluronan (HA).



FM's proposes a change in density, increased viscosity, of HA (29) may occur in injury or immobilisation significantly contributing to disfunction of the fascia's mechanical role with consequent impact upon associated structures - muscle, joints, nerves - and affect proprioception. This change in density is termed densification.

Densification refers to the process whereby HA undergoes aggregation changes in its molecular chain (28,29), losing much of its fluidity, becoming increasingly viscous, contributing to increased stiffness within the fascia tissue. It is suggested this occurs not only within the deep fascia but into the deeper muscle fascia: epimysium, perimysium, endomysium (17). Indeed, it is suggested, alterations of the HA and its affect on sliding of fascia tissue may be part of the aetiology of some pain experience (21,23,31).

The reduction of stiffening in localised tissues is arguably palpable to the practitioner, as is a change in sliding capacity of tissues during treatment. However, a more recent case study also implies an objective pretreatment and post treatment measure via elastography (30).

The relevance of this to the selected treatment approach is three-fold:

- i) Addressing increased viscosity of the HA by reversing the aggregation process, thereby allowing layers of deep fascia to glide, might restore appropriate biomechanical function to the tissue and mechanoreceptors contained within it. A personal question is *“might treating affected proximal fascia contribute to reduction of muscle guarding, via restoring of usual function and also having a positive neurophysiological affect?”*
- ii) If increasing stiffness of fascia occurs at the level of the perimysium, within which muscle spindles are partially imbedded (17), might this impact upon the crucial co-activation of intrafusal and extrafusal fibres, inhibiting their function? *Conversely, might reversing aggregation processes, reducing perimysial stiffness, improve co-activation status with a subsequent positive neurophysiological affect?* This emphasis upon the outcomes of fascia work being as much neurophysiological as mechanical / chemical is increasing (37). This was part of the clinical reasoning
- iii) Rather hopefully, a safety clinical reasoning point was: *might improvement in proximal muscle functionality, through FMs, serve to provide a stabilising factor of large muscle groups for distal, smaller structures that had long since ceased functioning properly?*

These latter 3 questions and points are my own and not to be confused with Stecco ideas per se.

5 Neurospecific Foot Mobilisation (NSM)

To be clear, the name of the mobs describes the primary treatment intent (nothing more), targeting Ruffini endings. This is achieved by working segmentally through the foot, whilst the segments are individually mobilised in traction, theoretically inducing a series of small dose afferent stimulations.

Slow adapting Ruffini mechanoreceptors are found within skin, ligaments, tendons (32) and portions of deep fascia, mainly around muscle expansions into deep fascia around joints (17). Ruffini are suggested to have a high sensitivity (32) and, as such, may respond (produce action potential) even with relatively weak stimulation (stretch) of the skin (32). They are also suggested to respond to lateral stretch (35).

As these SA2 receptors “down regulate the sympathetic nervous system” (33,36) they may, from an NSM perspective, have a place in reducing increased muscle tone. A further localised advantage for an NSM approach is that the extremities of the hands and feet hand are highly somatosensory areas of the body (33).

In cases of muscle guarding of the foot and ankle, a hoped for outcome of NSM is reduction of increased tonicity within the intrinsic muscles through the down regulation action of SA2 mechanoreceptors. It is one explanation of this, now third, case of muscle guarding treated. Each of these cases have been followed up and changes sustained.

In conclusion

At a localised level there is likely mechanical change via NSM. Anecdotally, in usual rehab contexts, I have found this to be both short term and long term, patient dependent. To that extent my more usual employment of NSM MT is as part of a care pathway (42). However, it is possible to utilise it in none muscle guarding contexts for a variety of presentations with significant gains for some individuals. A couple of these sessions can bring some long term gains for individuals, with clear psychosocial benefits arising from even small functional changes.

However, research suggests the primary mode of manual therapy action is neurophysiological (40) and will likely include placebo (41) has some localised mechanical affects (42) and moderating factors such as patient and practitioner expectation (42). Purposely, this discussion has not considered placebo but it is right to acknowledge there could be relationship between therapeutic discomfort / pain and placebo as part of these interventions / interactions. Equally, there is suggestion of some role in MT regards managing pain (42) that is more than placebo perhaps.

Over all though, the application of both the above selected manual interventions have a significant neurophysiological intent written within them and are applied in the hope of changes being brought about from that intent. Working fascial and foot mobilisation approaches, which have some biological plausibility, may facilitate neurophysiological changes. They are a reasonable clinical pathway in such instances of muscle guarding, especially if other conservative avenues have not succeeded.

That changes occurred (similarly in previous cases of significant muscle guarding treated) is undeniable but this approach to treating muscle guarding is a long way from being an affirmed way and needs proper research to explore it.

Appendix

Given the matter of type or subtypes of CRPS that are recognised and discussed, and length of time he has been symptomatic of it, a question is raised as to whether “CRPS” itself is still present or something else is now occurring. That is outside my scope to comment upon.

1. **CRPS.** This has been known to contribute towards a muscle guarding process (1,2,3) and this presentation appears to fit within the criteria, at the time of its original diagnosis.

- Preceding noxious event without (CRPS I) or with obvious nerve lesion (CRPS II) (5)
- Spontaneous pain or hyperalgesia/hyperesthesia not limited to a single nerve territory and disproportionate to the inciting event (5)
- Oedema, skin blood flow (temperature) or sudomotor abnormalities, motor symptoms or trophic changes are present on the affected limb, in particular at distal sites (5)
- Other diagnoses are excluded. (5)

3. As earlier mentioned he appeared to have come to terms with the limitation on his active life but there were some clear indications of a significant psychosocial impact. On the biopsychosocial element It can be easy to regard CRPS as being linked to an individuals psychology or type. However, a systematic review (5) commented:

No firm conclusion can be drawn from the literature between psychological factors and maintenance of CRPS 1.....no direct relation between psychological factors and development of CRPS 1..... Research

showed that there is no justification for stigmatising adult patients with CRPS1 as being psychologically different from other patients.” (Though it recognised the impact of life events and a need for more higher quality studies to be done and I am not suggesting emotional or psychological factors are to be ruled out in such cases.)

It is also worth noting that guarding is not always conscious or resulting from fear avoidance behaviour (4,6,34).

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