Reduction of Elective Amputations: Restoration of Function Through Manual Extremity Manipulation

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INTRODUCTION

Lower extremity limb salvage has been of increasing interest due to recent conflicts. While advances in technology allow for increased opportunities for surgeons to salvage limbs, this pursuit remains controversial (1, 2). Patients whose lower extremities are salvaged often require a longer period of rehabilitation when compared to those who opt for amputation (3). To the wounded warrior, a return to high levels of physical activity is often a top priority.

It is not uncommon for patients with salvaged limbs who do not reach their desired high level of physical activity to opt for elective amputation (3). This limb salvage failure ranges from 9% to 40% for conversion to secondary amputation (3). A major reason for elective amputation is impaired function resulting from llimited range of motion (ROM). Development of scar tissue adhesions known as anthrofibrosis, can be a major contributor to range and subsequent functional limitations. These limitations can be addressed through manual manipulation.

RATIONALE

The aim of this case series is to demonstrate the potential of manual manipulation to improve mobility and function for wounded warriors who have sustained high-energy lower extremity trauma, even after a standard rehabilitation protocol for salvaged limbs of the lower extremity has reached a plateau.

MATERIALS and METHODS

SUBJECTS

- Three patients, age: 26 – 37 years
- Sustained poly-trauma injuries: including ankle fractures
- Time from injury to first chiropractic treatment: 11 - 20 months

TREATMENT/INTERVENTION

- Progress has plateaued in physical therapy
- Referred for 3-D gait analysis
- Referral to chiropractic care
  - Prescribed program: two treatments/week for three months.
  - Treatment:
    - Manual manipulation of talocrural joint, subtalar joint, transverse tarsal joints and tarsometatarsal joints
    - Adjunct modalities and soft tissue (myofascia) manipulation of plantar fascia, gastrocnemius, and soleus muscles

MEASURES

- 3-D gait analysis performed:
  - Pre and post chiropractic treatment
- Gait analysis system included:
  - Motion capture: 27 infrared Vicon cameras (Oxford, UK)
  - Data processed: Visual 3-D, C-Motion (Germantown, MD)

TREATMENT METHODS

These figures illustrate examples of manual manipulation techniques used.

Manual manipulation of the cuneonavicular joint(s).

Tibiotalar posterior to anterior glide manipulation.

Manipulation of the talus.

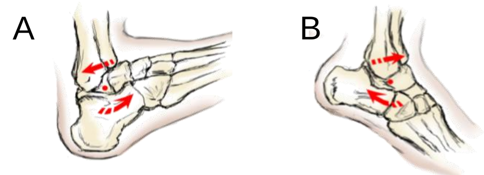
Manipulation of subtalar joint.

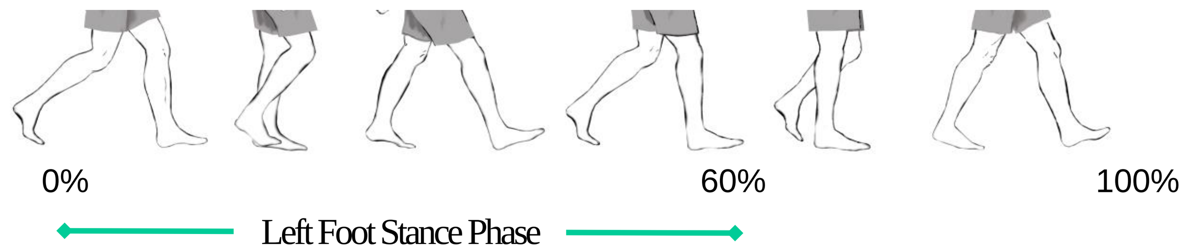
Instrument assisted myofascial release of myotendinous junction of calf.

Instrument assisted myofascial release of plantar fascia.

GAIT LAB METRICS

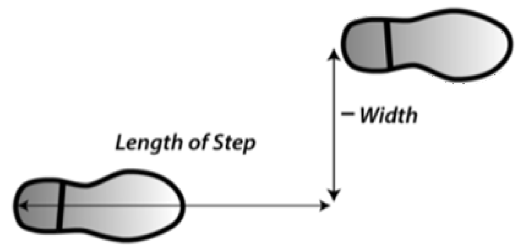
1. Ankle dorsiflexion (A) and plantarflexion (B).





2. Stance percentage: the percentage of a gait cycle spent with one foot in contact with ground (heel strike to toe off), typically ~60% of the gait cycle. Measured and denoted on each side.

3. Step length: distance covered in one step measured from the heel strike of one foot to the heel strike of the contralateral foot.



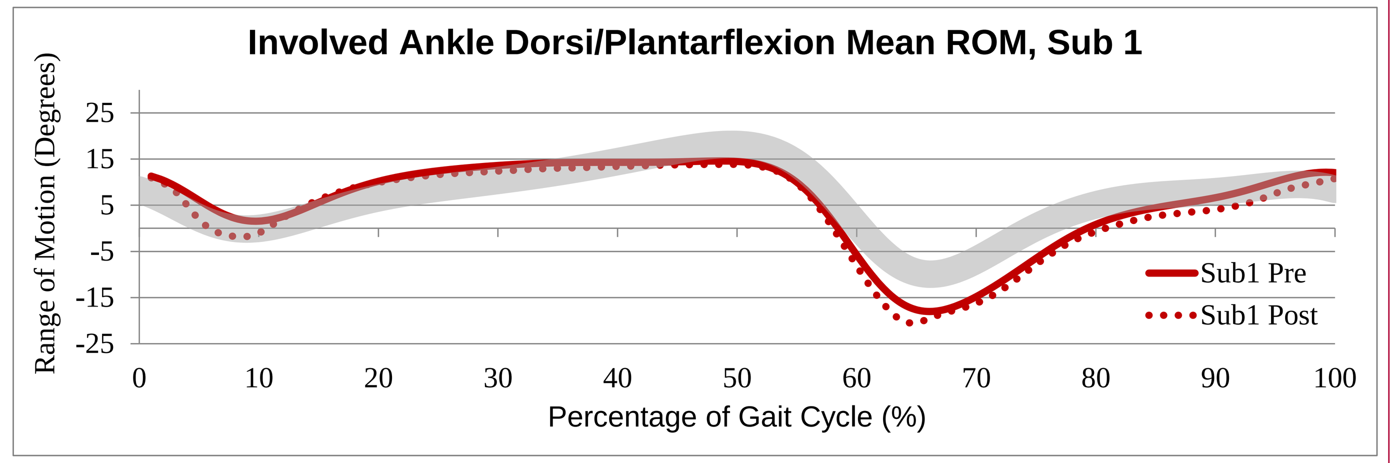
4. Step width: distance between the mid-heel of one foot to the other from heel strike to contralateral heel strike.

RESULTS

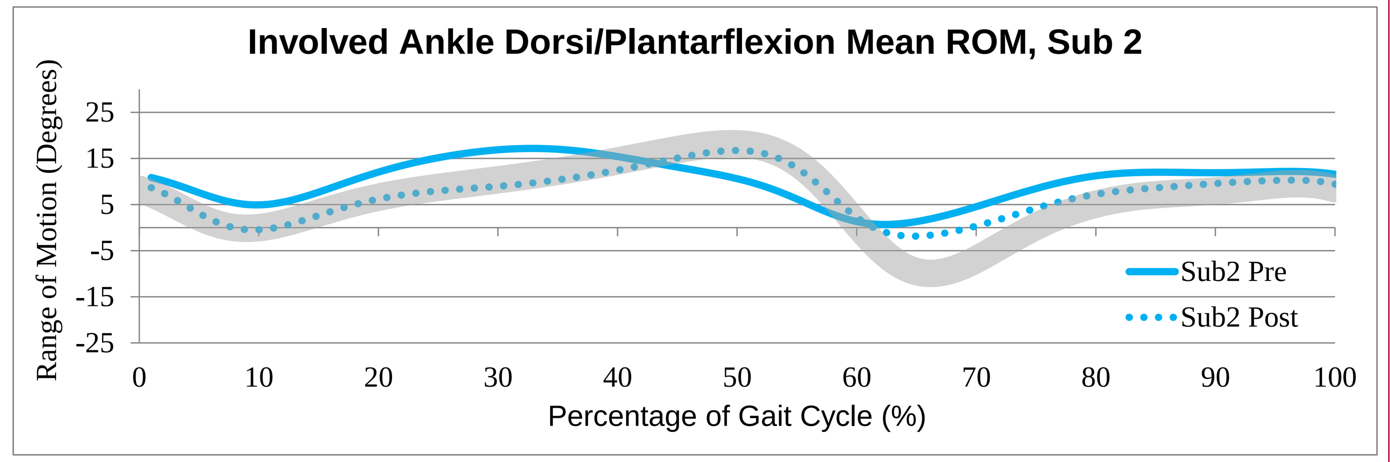
Table 1: Temporospatial parameter means of all patients (Sub) at their self-selected walking speed pre and post manual manipulation treatments compared to uninjured military collected in the same biomechanics laboratory.

Patient	Visit	Treatments/ Time (days)	Speed (m/s)	Stance Percentage L (%)	Stance Percentage R (%)	Step Length L (m)	Step Length R (m)	Step Width (m)
Sub1	Pre	3/55	1.16	68.9	67.4	0.65	0.65	0.21
	Post		1.39	66.6	66.1	0.72	0.73	0.22
Sub2	Pre	11/120	1.21	68.0	64.5	0.61	0.69	0.19
	Post		1.50	63.1	62.2	0.75	0.76	0.15
Sub3	Pre	30/145	1.19	68.7	65.7	0.59	0.67	0.23
	Post		1.62	65.6	64.7	0.71	0.82	0.21
Uninjured	-	-	1.48	64.19		0.78		0.14

1a



1b



1c

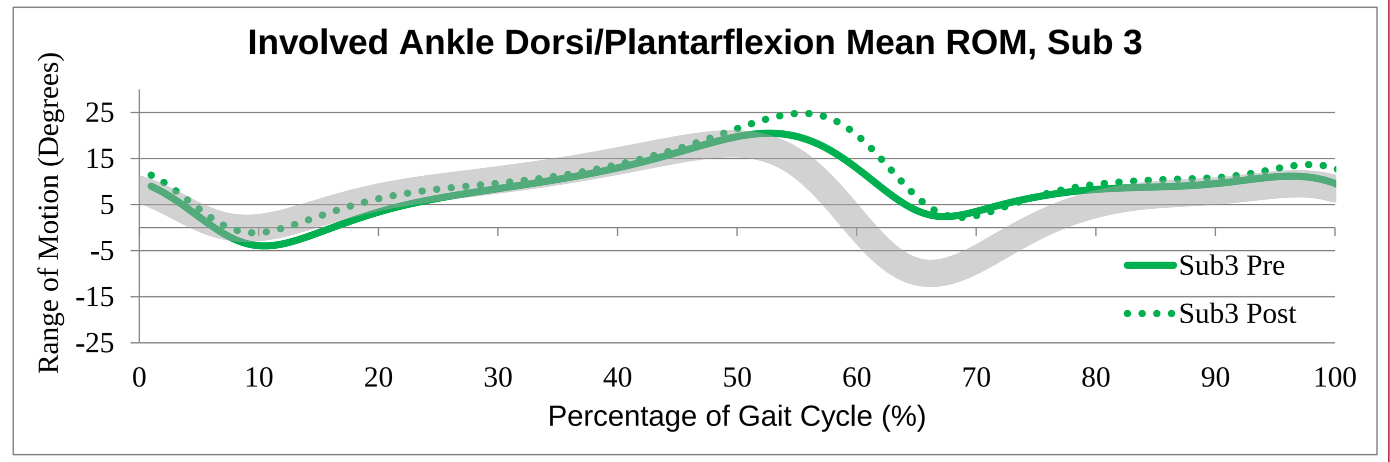


Figure 1a-c: Dynamic range of motion means (in degrees) of all participants pre and post treatment. Initial visit indicated by solid line and visit after treatment is represented by dotted line. Gray band indicates mean ROM from an uninjured population collected in the same lab. Walking pace depicted is within 0.1 m/s for each participant for comparison. The range is taken from right heel strike to subsequent right heal strike over one gait cycle.

RESULTS (cont)

All patients demonstrated varying degrees of change in ankle kinematic and temporospatial measures after manual manipulation treatments:

- Self selected walking speed increased 0.23 m/s to 0.43 m/s for all patients (Table 1)
- Stance symmetry increased for all patients , in addition to a decrease in stance percentage
- Step length increased for all patients by an average of 10 cm (± 5 cm); symmetry for step length increased for Sub2 and remained constant for the other patients
- Sagittal ankle ROM was altered in all patients (Figure 1a-c): Sub1 and Sub2 exhibited an increase in plantarflexion, Sub3 displayed an increase in dorsiflexion

DISCUSSION

The temporospatial measures and sagittal ankle ROM improved for all patients after manual extremity manipulation. Symmetry both in stance and step length were improved for all, speed improved, and step length decreased for 2 of the 3 patients, showing an improvement. Sub2 had the most dramatic increase in ROM and pattern post manipulation with increased plantarflexion and progression of ankle motion within normal limits. Both Sub1 and Sub3 also experienced an increase in ROM along with exhibiting more normal ankle dorsiflexion and plantarflexion patterns.

Although there was a broad range in onset and number of treatments as well as the time over which they occurred, this helps illustrate the diversity of injuries as well as the benefit of treatment. This case series incites the question of dosage: What is the optimal frequency and duration of manual intervention?

The impact of this study is twofold. The patient directly benefits through an improved quality of life resulting from increased range of motion and improved function of the lower extremity. Indirectly, the patient can benefit through eliminating the societal financial burden that would result from an elective amputation.

The results from this case series raise questions that warrant further research: Should manual manipulation be incorporated as a standard of care for limb salvage rehabilitation? How early should manual manipulation be initiated post injury to maximize its effects on optimizing biomechanical physiology?

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