

# A Step in the Right Direction: Orthotics in the Military



## ORTHOTICS FOR THE TREATMENT OF LOWER EXTREMITY INJURIES

Capstone Project

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### Introduction



Basic military training involves many physical activities throughout the day including running.

Overuse injuries are pathologies that result from high intensity training and can prevent runners and other athletes from participating in training related activities. There are several important risk factors to evaluate when examining persons with overuse injuries, including:

weekly running distance, history of injuries, number of years training, training characteristics, running and/or training surface, and footwear. Conservative treatment for overuse injuries usually involves training modification, anti-inflammatory medications, and physical therapy. Orthoses are a tool in physical therapy that can be used to correct lower extremity biomechanics, provide sensory input, and decrease muscle work in these patients.<sup>1</sup>

The research regarding custom orthoses for

the treatment of overuse injuries is not specific to the military population. However much of the research has been performed on high level activity athletes such as runners which may help generalize results to the military.

The following is a review of some of the current research on orthoses for treatment of overuse injuries. The figure below is a quick reference of the research parameters. As with much of the orthotic research there is variation between study parameters, how orthoses were fabricated, and outcome measures. Therefore all research is presented and analyzed separately.

Overall orthoses tend to decrease pain and increase function in people suffering from overuse injuries. With many of these injuries orthoses are beneficial without having to change activity levels or lifestyle. This fact may be particularly useful for recruits dealing with these conditions during basic military training.

### Inside this issue:

General Overuse Injuries	2
CHRONIC BACK PAIN	2
PATELLOFEMORAL PAIN SYNDROME	3
MEDIAL TIBIAL STRESS SYNDROME	3
PES CAVUS	4
POSTERIOR TIBIAL TENDON DYSFUNCTION	4
ACHILLES TENDINOPATHY	5
PLANTAR FASCIITIS	5
REFERENCES	6

Condition	Study	N	Follow-Up	P-value (<.05)	Condition	Study	N	Follow-Up	P-value (<.05)
General <sup>1</sup>	RCT	99	8	Yes	Pes Cavus <sup>5</sup>	RCT	154	12	Yes
Back Pain <sup>2</sup>	Prospective Cohort	32	4/24	Yes	Posterior Tibial Tendon Dysfunction <sup>6</sup>	Prospective Cohort	36	12	Yes
Patellofemoral Pain Syndrome <sup>3</sup>	RCT	179	6/12/5/2	Yes	Achilles Tendinopathy <sup>7</sup>	RCT	31	4	Yes
Medial Tibial Stress Syndrome <sup>4</sup>	Prospective Cohort	23	3	Yes	Plantar Fasciitis <sup>8</sup>	RCT	136	12/52	Yes

Table 1. General information regarding literature presented. RCT: Randomized controlled trial, N: number of subjects, Follow-up: reported in weeks, P-value: statistical significance

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## General Overuse Injuries

### Common Overuse Injuries:

- PATELLOFEMORAL PAIN SYNDROME
- ILIOTIBIAL BAND SYNDROME
- TIBIAL STRESS SYNDROME
- LOW BACK PAIN
- CHRONIC EXERTIONAL COMPARTMENT SYNDROME
- PLANTAR FASCIITIS
- TENDINOPATHIES

There are many different types of overuse injuries that are common in runners and other active individuals. Orthoses could help reduce pain and increase function for people suffering overuse injuries by improving lower extremity biomechanics.<sup>1</sup>

The effects of custom semi-rigid orthoses on runners with unilateral overuse conditions has been examined. The investigation included the most common overuse conditions in order to study the effectiveness of orthoses on these injuries as a whole. Patients were avid runners (>32 km/week) experiencing chronic overuse pain and symptoms (>3 months). Patients were allocated to either the custom orthoses or control group. Patients were allowed to maintain their activity and training levels.<sup>1</sup>

The custom orthoses were produced from dynamic plantar pressure distribution measurements for each individual patient. The patients were advised to wear neutral running shoes with their new orthoses.<sup>1</sup>

After 8 weeks patients wearing the orthoses had reduced self-reported pain (Subjective Pain Experience Scale) and disability (Pain Disability Index) compared to the controls. The investigation also revealed that most runners reported high comfort scores (around 80%) with the orthoses.<sup>1</sup>

The results support use of orthoses to reduce pain and impairment associated with overuse injuries in runners without activity modification. The results may not generalize to less active populations and could be limited to tendinopathies which were the most common condition reported.<sup>1</sup>

## Chronic Low Back Pain

There are many potential reasons for chronic low back pain for which a detailed evaluation of the patient is required. One possible mechanism for low back pain is a sagittal plane blockage at the foot (functional hallux limitus and ankle equines) which would cause abnormalities in gait. Sagittal plane blockage can result in compromise of preswing limb positioning and toe off as well as lateral trunk bend. The presence of poor gait mechanics can lead to increased stress and pain at the lumbar spine. Custom orthoses can be used to address gait abnormalities and therefore help reduce pain at the low back.<sup>2</sup>

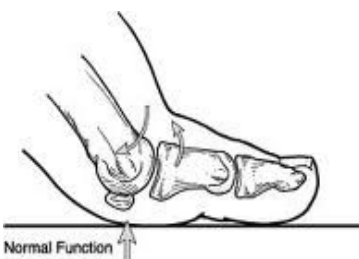
The use of orthoses were studied in this specific subset of chronic low back pain patients with gait abnormalities. All types of low back pain were included (sacroiliac, mechanical, spinal stenosis, etc). All patients received custom or-

thoses and when applicable manipulations (1st MTP joint, ankle, or fibular head) to increase range of motion.<sup>2</sup>

The custom orthoses were made from impressions taken from a semi-weight bearing position. Modifications to orthoses were also made after gait analysis.<sup>2</sup>

The patient's scores from the Quebec Back Pain Disability Scale questionnaire were converted into a mean pain score for analysis. At both short and long term follow-ups the patients demonstrated a mean reduction in their back pain score.<sup>2</sup>

Although the results were considered statistically significant in the investigation the clinical changes were actually very small. The pain reduction appeared to be only about 1 point. The investigation also had a small sample size and low follow-up. Therefore these results should be interpreted with caution.<sup>2</sup>



Functional hallux limitus refers to decreased range of motion at the 1st metatarsophalangeal joint (MTP; big toe) during gait.

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## Patellofemoral Pain Syndrome

Patellofemoral pain syndrome (PPS) is associated with anterior knee pain which is aggravated with squatting, stairs, and/or running. Almost 19% of all running related injuries are connected to PPS and tend to be chronic in nature. PPS can negatively affect recreational and occupational activities especially if the activities listed earlier are involved. Custom orthoses may benefit PPS patients by controlling ankle/foot motion and plantar pressure distribution which could improve lower extremity biomechanics.<sup>3</sup>

A well designed investigation studied the short and long term effects of orthoses on patellofemoral pain. Patients with PPS were divided into four groups: physical therapy, orthoses, physical therapy plus orthoses, and a sham group. Patients were followed for 52 weeks.<sup>3</sup>

## Medial Tibial Stress Syndrome

Medial tibial stress syndrome (MTSS) is an overuse injury that presents with pain across the distal aspect of the tibia. MTSS is a common exercise-related injury that occurs as high as 35% in the military population. The exact cause of this pain is currently under dispute but risk known risk factors include excessive pronation of the foot and rear- or fore-foot varus. The use of custom orthoses to support the medial longitudinal arch and/or fore-foot could aid in controlling these biomechanical risk factors and reduce pain.<sup>4</sup>

A small investigation on the effects of orthoses and concurrent stretching program was performed on active individuals (> 10 miles/week) with medial tibial stress syndrome. Patients were not allowed to receive any other interventions. Patients were issued prefabricated orthoses and taught twice daily gastrocnemius and soleus stretching.<sup>4</sup>

The orthoses were prefabricated but were customized by heat molding and the addition of wedges. The physical therapy intervention involved joint mobilizations, patellar taping, quadriceps training, and education.<sup>3</sup>

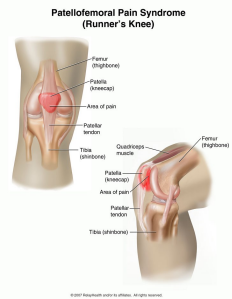
At the short term follow-up (6 weeks) there were no differences between intervention groups. The orthoses group did reduce the relative risk ratio and number needed to treat when compared to the sham group. No significant differences were seen at 12 or 52 weeks.<sup>3</sup>

Orthoses appear to have the same gains as physical therapy in the short term for patellofemoral pain. The use of orthoses may hasten recovery in patients with PPS and be more cost effective over time. Patient preference should be determined to promote adherence to treatment.<sup>3</sup>

The short term follow-up demonstrated a successful outcome (50% improvement in Numerical Pain Rating Scale) in 44% of women and 83% of men. There was a significant difference in pain levels between successful and unsuccessful groups.<sup>4</sup>

The results indicated that men seem to respond more favorably to orthoses and stretching treatment than women. The investigators also discovered that duration of symptoms appeared to be a poor indicator for improvement.<sup>4</sup>

The investigation's results should be interpreted with caution due to its small sample size and no true control group to comparison. The use of orthoses and stretching seem to improve pain symptoms in the short term but further research needs to be completed on long term benefits. The use of additional interventions or activity modification may be required to reduce pain levels further.<sup>4</sup>



PPS presents as anterior knee pain and is highly associated with running.

### Signs & Symptoms of MTSS:

- PAIN AT BEGINNING AND END OF RUNNING
- PAIN WITH PASSIVE DORSIFLEXION
- PAIN WITH RESISTED PLANTARFLEXION
- PAIN WITH TOE RAISES AND SINGLE LEG HOPS



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Pain typically located at the distal 2/3rds of the posteromedial tibia.

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Pes cavus presents with a high medial longitudinal arch compared to normal feet. This can change the distribution of plantar pressures across the foot.

## Pes Cavus

Pes cavus, or high arches, is characterized by a high medial longitudinal arch and is prevalent in about 10% of the general population. Pes cavus typically presents with multi-planar foot deformities including a varus rearfoot, plantar-flexed first metatarsal, and clawing of phalanges. Almost 60% of people with pes cavus experience foot pain which is usually contributed to abnormal pressure loading during activity. Custom orthotics can be molded to the specific shape of pes cavus feet and help better distribute plantar pressures throughout the foot.<sup>5</sup>

The effects of custom orthotics for painful pes cavus have been compared to sham treatment. Patient's with bilateral pes cavus and chronic foot pain (> 1 year) were allocated to either semi-

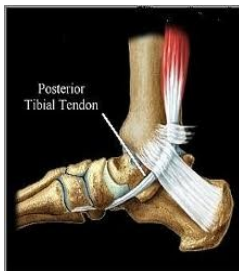
rigid custom orthoses or sham group. Orthoses were created from neutral suspension plaster casts. In addition to orthoses or sham, the patients were allowed to continue other interventions.<sup>5</sup>

At 3 months the orthotic patients improved in their mean pain and function scores (Foot Health Status Questionnaire) and their physical functioning quality of life (SF-36 Health Survey) compared to controls. The patients wearing orthoses also had statistically significant differences in plantar pressure distribution.<sup>5</sup>

Plantar pressure maps demonstrated more even distribution of weight throughout the foot. Whole foot, rearfoot, and forefoot pressures were reduced while midfoot pressure increased. This helps support the idea of pain reduction through pressure redistribution.<sup>5</sup>

## Stages of Posterior Tibial Tendon Dysfunction

- STAGE 1: MILD SWELLING, MEDIAL ANKLE PAIN, PAINFUL HEEL RISE
- STAGE 2: FLATTENING OF ARCH, ABDUCTED MIDFOOT, FLEXIBLE HINDFOOT, UNABLE TO PERFORM HEEL RISE
- STAGE 3: STAGE 2 BUT WITH RIGID HINDFOOT
- STAGE 4: VALGUS TILT OF TALUS WITHIN ANKLE MORTISE



The posterior tibial tendon originates at the calf muscles, wraps around the medial malleolus, and attaches at the navicular bone in the foot. The navicular provides support to the arch.

## Posterior Tibial Tendon Dysfunction

The posterior tibial tendon wraps around the medial malleolus and provides stability and support to the arch of the foot. Posterior Tibial Tendon Dysfunction (PTTD) from tendon degeneration can cause medial ankle pain, walking dysfunction, and foot deformities including pes planus (flat foot), abducted midfoot, and/or a rigid hindfoot. PTTD is thought to be a leading contributor to acquired pes planus deformity. Orthotics could help support the arch of the foot preventing further lengthening of the tendon or deformity as well as providing a better length tension relationship for the calf muscles.<sup>6</sup>

There are currently no guidelines for treatment of early stage (I or II) posterior tibial tendon dysfunction. Early stages present with swelling, ankle pain, and progress to flexible foot deformity.

A combination of treatments have been

examined in their relation to PTTD. Patients with stage I or II PTTD were assigned to orthoses and stretching, orthoses and concentric exercise, or orthoses and eccentric exercise. Patients were asked to discontinue all physical activities.<sup>6</sup>

Stretching consisted of gastrocnemius and soleus stretching twice per day. The exercise groups focused on the tibialis posterior musculotendinous unit.<sup>6</sup>

All groups demonstrated decreased pain and disability with treatment (Foot Function Index). Pain after the 5-minute walk test was also reduced for all groups (Visual Analog Scale).<sup>6</sup>

The use of orthoses and stretching provides positive gains for patients with PTTD. The use of either concentric or eccentric exercise augmented these effects. The use of rest and activity modification could have also influenced the healing process.<sup>6</sup>

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## Achilles Tendinopathy

Achilles tendinopathy (AT) is an overuse injury that is characterized by a loss of overall tendon structure. The disorganization of collagen structure from abnormal repair mechanisms results in a weak and painful tendon. Pain associated with AT is usually a limiting factor in activities of daily living, occupational activities, and sports. Orthoses may aid in pain reduction by helping support the longitudinal arch and stabilizing the rearfoot.<sup>7</sup>

The use of custom orthoses for Achilles tendinopathy has been studied in the running population. Runners (> 32 km/week) with chronic (> 6 months) unilateral AT were recruited. The patients were distributed to three different groups: physical therapy, custom semi-rigid orthoses, or no treatment. The patients were allowed to previous training regimen.<sup>7</sup>

## Plantar Fasciitis

The plantar fascia is the fibrous connective tissue that reaches from the inferior heel to the toes that supports the arch of the foot. Plantar fasciitis (PF), inflammation of the fascia, is a regular injury in runners and is one of the most common foot problems. The use of orthoses have been proposed to aid in the reduction of PF symptoms by supporting the arch and decreasing foot pronation therefore reducing strain on the fascia.<sup>8</sup>

Short and long term benefits of different types of orthoses for plantar fasciitis have been previously examined. Patients with chronic PF (>4 weeks) were assigned to a sham, prefabricated, or custom semi-rigid orthoses. The custom orthoses were made from plaster casts of the feet in neutral positioning, The patients received no other interventions during the investigation.<sup>8</sup>

The custom orthoses were produced from plantar pressure distribution measurements with longitudinal arch support and bowl shaped heel. The physical therapy group consisted of: deep friction massage, ultrasound, ice, and sensory motor training.<sup>7</sup>

Physical therapy and custom orthoses interventions provided pain reduction (Pain Disability Index) for patients with Achilles tendinopathy in 4 weeks.<sup>7</sup>

Both interventions appeared to benefit patients with AT in the short term without activity modification. Since both interventions provide similar effects the patient's preferences should be considered (time, economics, and/or comfort). The long term effects of the interventions were not evaluated therefore conclusions cannot be made.<sup>7</sup>

Both the prefabricated and the custom orthoses improved patient function scores (Foot Health Status Questionnaire, FHSQ) at the 3 month follow-up compared to the sham group. The mean pain scores (FHSQ) for both orthotic groups also decreased at 3 months but were not statistically significant. At 12 months there were no differences between any groups for pain or function (FHSQ).<sup>8</sup>

Based on the investigation results prefabricated orthoses appear to provide the same benefits as custom orthoses in the short term for plantar fasciitis. Using prefabricated orthoses can be a less expensive method of providing orthotic intervention.<sup>8</sup>

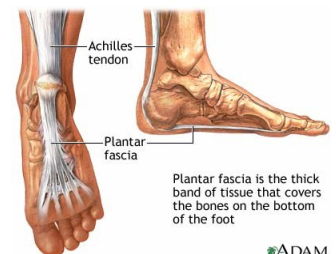
Orthotics can be used to improve early function and reduce pain in patients suffering from plantar fasciitis. The use of additional interventions may be useful.<sup>8</sup>



The Achilles tendon originates at the calf muscles and inserts onto the calcaneus (heel). The Achilles tendon is active during walking, running, and jumping.

### Common Plantar Fasciitis Symptoms

- HEEL PAIN
- PAIN UPON GETTING OUT OF BED (RESOLVES WITH WALKING)
- PAIN AFTER LONG PERIODS OF REST (RESOLVES WITH WALKING)
- PAIN AFTER EXERCISE



# A Step in the Right Direction: Orthotics in the Military

ORTHOTICS FOR THE TREATMENT OF LOWER EXTREMITY INJURIES

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