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Case Study

The inclusion of vibration therapy in rehabilitating a gastrocnemius tear: a case study in master athlete

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Abstract. [Purpose] The aim of this case study was to determine if VT could be included into a rehabilitation programme by monitoring the progress of muscle pain, range of motion and muscle strength. [Participant and Methods] An international male master hockey player sustained a medial gastrocnemius 5 cm tear prior to the World Cup. VT was applied early in the rehabilitation programme where 9 sessions of VT were performed during the first 16 days. Other conventional rehabilitative exercises were included. [Results] Twenty-eight days post-injury the athlete returned to full playing. Calf pain had subsided by day 8 with a change of 12° in ankle dorsi flexion range of motion. Grade 5 calf strength was attained by day 16, which was equivalent to the unaffected limb's strength. There were no residual side effects of including VT into the rehabilitation programme and it did not compromise the athlete's recovery. [Conclusion] To ensure optimal loading of VT, 9 sessions were implemented and progressively increased; consequently, there was no detrimental effect on the rehabilitative process. The athlete reported no side effects of using VT and its ease and time efficient application has a role to complementing soft tissue injury rehabilitation.

Key words: Dorsiflexion range of motion, Field hockey, Muscle pain

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INTRODUCTION

An acute tear to the medial gastrocnemius is a common condition that frequently occurs in athletes from large running volumes or high-velocity running, acceleration and deceleration[1)]. In football match-play gastrocnemius injury occurs in 0.84 per 1,000 hours[2)] and in rugby union the prevalence of a gastrocnemius injury has a risk ratio of 0.98 to 5.85[3)]. Conventional treatment initially focuses on limiting the haemorrhage and pain, followed by passive and active stretching, proprioceptive training and strengthening. To assist the rehabilitation process it is common practice to include other physical therapy modalities such as ultrasound, electrical stimulation, dry needling and massage. Another method that is gaining popularity in medical and rehabilitation fields is the use of vibration therapy (VT). The proposed VT benefit is thought to involve the spinal reflex mechanism that elicits an excitatory response of the muscle spindle to enhance muscle power[4)]. Additionally, acute vibration has the capacity to increase muscle temperature[5)], which is central to optimising muscle function[6)] and exercise-associated rehabilitation[7)]. Research has also supported low frequency VT (13–45 Hz) to reduce muscle soreness[8, 9)], improve anterior cruciate ligament recovery from reconstructive surgery[10, 11)] and complement standard treatment for Achilles tendinopathy[12)]. The aim of this case study was to determine if VT could be integrated with standard rehabilitation procedures by monitoring outcome measures of muscle pain, range of motion and muscle strength during soft tissue injury of the gastrocnemius.

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PARTICIPANT AND METHODS

An international master male field hockey athlete (age 40 yrs, height 178 cm, body mass 77.5 kg) was healthy and aerobically conditioned (VO_2 max of 60 mL kg^{-1} min^{-1}) prior to the injury. This study complies with the ethical standards of the Declaration of Helsiniki and was approved by the institutional ethics committee and informed consent was obtained from the athlete.

Prior to the national training camp, the athlete had been training for 27 weeks and Table 1 illustrates the training phases, type and number of sessions performed. On average, the athlete attainted 5.1, 5.3 and 5.2 sessions per week in the general preparation, pre-competition and club competition phases, respectively.

Three-and-half weeks from departing to the Masters World Cup, the injury occurred during the warm-up on the first day of a two-day national training camp. The athlete was jogging across the field when a sharp pain sensation occurred in the left calf muscle; his immediate reaction was that a hockey ball had struck him. Upon stopping there was no ball in site so the athlete continued jogging but could not sufficiently 'push-off' from his left foot and limped to the dugout. The athlete reported severe pain in the left calf and walking was intolerable that the athlete did not take any further in the training camp.

Three days post-injury a clinical examination revealed pain in the left medial gastrocnemius while performing active and passive plantar flexion, the Thompson squeeze test was negative for an Achilles rapture, and on palpation there was tenderness of the left medial gastrocnemius at the musculotendinous junction. An ultrasound scan revealed a separation of the distal left medial gastrocnemius from the soleus at the medial gastrocnemius/soleus aponeurosis of 5 cm. But there was no significant haemorrhage, no deep vein thrombosis or Baker's cyst and the Achilles tendon was normal. Based on the epidemiology, mechanism of injury, clinical and ultrasound findings the athlete was diagnosed with a medium sized tear involving the left medial gastrocnemius/soleus aponeurosis. Medium sized tears have a healing time of approximately 6–7 weeks[13)] and with a time-frame of 25 days to the World Cup, the player withdrew from the team to focus on his rehabilitation.

Currently, there are no specific patient-reported outcome measures for gastrocnemius tears. Calf pain rating, ankle dorsiflexion range of motion and calf muscle strength were used to monitor progress and were recorded on day 1, 8, 16, 24 and 27 for the affected calf, with the measurement of the unaffected calf occurring on day 1 only.

Perceived calf pain was measured using a visual analogue scale (VAS)[14)]. Ankle dorsiflexion range of motion (Dorsi-

Table 1. The type of training and number of sessions completed in each training phase prior to the national training camp

General preparation phase (11 weeks)	
Type of training	Number of sessions
Aerobic continuous	20
Aerobic long duration intervals	15
Aerobic time trials	7
Individual skill	11
Power/Sprint/Strength	3
Total	56
Pre-competition phase (3 weeks)	
Type of training	Number of sessions
Aerobic continuous	7
Aerobic medium duration intervals	6
Individual skill	1
Strength	2
Total	16
Club competition phase (13 weeks)	
Type of training	Number of sessions
Aerobic continuous	17
Aerobic short duration intervals	9
Individual skill	14
Strength	6
Sprint	1
Power	2
Matches	8
Club team trainings	11
Total	68

ROM) was assessed with a manual goniometer in accordance to Coombes and Skinner[15] protocol. Calf muscle strength was assessed according to Avers and Brown[16] using five-point grading scale. This included the patient lying prone with feet positioned at the end of the table and attempted ankle plantar flexion. When there is no palpable contraction it was graded zero, however if the tendon reflects some contractile activity in the muscle but no joint motion occurs it was graded one. In a standing positon, using two fingers for balance with knee extended, if the patient successful achieved a heel raise from the floor through the full range of plantar flexion and received a grade two. In the same standing position for grade 2, the patient competed 1–9 heel raises with no rest or fatigue was classified as grade 3. When the patient completed 10–24 successful heel raises without rest or fatigue it received a grade four. Grade 5 is conferred with the patient successfully completing a minimum of 25 heel raises without rest or fatigue.

The rehabilitation plan is outlined in Table 2 and outcome measures are documented in Table 3. Nine sessions of VT were performed during the first 16 days. A commercial machine with a motorised platform generated side-alternating vertical sinusoidal vibrations (Galileo Sport, Novotec, Pforzheim, Germany). This machine rotates around an anteroposterior horizontal axis, so when the feet are further from the axis results in a greater displacement of the vibrating platform. In socked

Table 2. Detail prescription of the rehabilitation programme

Days post injury	Purpose	Rehabilitation
1–3	Reduce inflammation, control swelling and pain	Assessment of injury, conservative management of protection, optimising-loading, ice, compression, elevation.
4–8	Restore full range of motion include non-weight bearing cardio	VT × 4: 10 Hz, 6.5 mm, 4 × 60 sec with 60 sec rest progress to 10 Hz, 6.5 mm, 8 × 60 sec with 60 sec rest, + stretching (calf & soleus) 20–30 sec × 10, 2 sets, to pain tolerance. Cardio × 4: Stationary cycle 20 mins, 55–60% HR_{max} Stretching × 3: Seated calf stretch with theraband without pain. 5–10 sec × 10, 2–3 sets. Active ankle ROM – seated on floor plantarflexion/dorsiflexion ankle × 10, 2–3 sets. Physiotherapy × 1: Pain control, gentle passive ROM exercises.
9–16	Restore strength and increase cardio intensity	VT × 5: 15 Hz, 6.5 mm, 8–10 × 60 sec with 60 sec rest, + stretching (calf & soleus) 20–30 sec × 10, 3 sets, no overstretching into pain. Strengthening × 6: Bilateral standing body-weight calf raises 10–15 reps, 2 sets progressing to unilateral standing body-weight calf raises 12–15 reps, 2 sets. Cardio × 3: Rowing/Cycling 20 mins, 65–70% HR_{max} Stretching × 1: Calf & soleus 20–30 sec × 10, 3 sets, to pain tolerance Physiotherapy × 2: Passive ROM exercises, pain-free weight bearing strengthening
17–24	Restore high speed and power. Progress non-weight bearing cardio to running	Running × 5: Treadmill 15 min @ 12 progressing to 15 km/hr. Treadmill intervals 10 × 60 sec, 60 sec rest @ 17 km/hr progressing to running outside 32 mins @ 4:45 min/km pace. Explosive Strength × 3: Stationary unilateral leg hopping 10–12, 2–3 sets progressing to dynamic bilateral hopping 10 m 4 reps. Sport specific × 1: Sprint training 6 × 20 m starting at 50% building to 75% max effort (set 1), 90% max effort (set 2) slow deceleration. Stretching × 2: Calf & soleus 20–30 sec × 10, 3 sets, to pain tolerance. Physiotherapy × 2: Strengthening and dry needling.
25–28	Return to sport	Sport specific × 1: Skill training with stick and ball. Team training × 1: 60 mins including: skill/technique, set plays, high intensity sprinting and changes in direction. Club game × 1: Complete full game without any side effects.

VT: vibration therapy; HR_{max}: heart rate maximum; ROM: range of motion.

Table 3. Outcome measures of calf pain, ankle dorsiflexion range of motion and calf strength of affected and unaffected limb

Days after injury	1		8	16	24	27
Limb	Unaffected	Affected	Affected	Affected	Affected	Affected
Calf pain (VAS)	0	94	5	0	0	0
Dorsi-ROM (°)	15	−5	7	12	12	13
Calf strength (grade)	5	1	3	5	5	5

VAS: Visual analogue scale; Dorsi-ROM: ankle dorsiflexion range of motion; a minus value represents a position of ankle plantar flexion; a positive value represents a position of ankle dorsiflexion.

feet, the athlete placed each foot 18 cm from the central axis, which equated to a peak-to-peak displacement of 6.5 mm and was instructed to distribute the body mass through the soles of his feet. A static squat at a knee angle of 120° (measured by a manual goniometer) was maintained throughout the vibration exposure.

Currently, there is no recommended vibration protocol for rehabilitation, but an intermittent protocol of 60 sec exposure with 60 sec rest has been reported in previous rehabilitation research[11]. Given that there are no clear guidelines on the use of VT for soft tissue injury, a cautious approach was undertaken to selecting a low level of vibration frequency (10–15 Hz). VT was progressively overloaded by increasing the vibration frequency and/or the number of exercise repetitions. Following VT, calf stretching was performed in a seated chair with a thera-band anchored around the foot with the ankle dorsiflexed for 5–10 sec without overstretching into pain. Ten repetitions of 2–3 sets were completed. This was progressed to standing calf and soleus stretching of 20–30 sec (10 repetitions, 2–3 sets) to pain tolerance.

RESULTS

After sustaining a medial gastrocnemius 5 cm tear the athlete's calf pain had almost subsided by day 8 with a corresponding change of 12° in Dorsi-ROM. By day 27 Dorsi-ROM was within 2° of the unaffected Dorsi-ROM of 15°. Grade 5 calf strength was attained by day 16, which was equivalent to the unaffected limb's strength and VT caused no discomfort during treatment. The athlete returned to full play on day 28 and was running, sprinting and performing hockey specific skills to the same level prior to the injury with no residual impairment in gastrocnemius muscle function. The athlete continued to play in premier club hockey for the remaining season (an additional 5 weeks) without any further symptoms and complications.

DISCUSSION

The current results show that the use of low frequency VT did not compromise the athlete's recovery but further research is required to determine if VT can expedite the return time to competition. Vibration is known to increase calf blood flow[17] that may improve nutrient supply in assisting with the healing process and reduces muscle inflammation. In support of this, Broadbent et al.[8] observed that VT reduced lymphocyte and interlukin-6 after downhill running and proposed that VT may be an effective modality to treat soft tissue injuries. Therefore, from the current results it is plausible that the early treatment of VT may have promoted an immune response; additionally, low frequency vibration (8–10 Hz) has been shown to stimulate satellite myoblasts that may enhance muscle regeneration[18]. It is beyond the scope of this paper to determine the possible VT mechanism(s) in reducing muscle inflammation and activating satellite cells; however, changes in blood flow, muscle temperature and tonic vibration reflex are possible candidates.

VT was applied 4-days post injury, which is a similar period to earlier research that treated acute and subacute hamstring tears. The researchers observed that 10 minutes of intermittent direct VT (20 Hz) was effective at increasing flexibility and reducing perceived stiffness compared to 20 minutes of ice, compression and elevation[19]. VT has the capability to stimulate proprioceptors to improve knee proprioception in patients with ACL reconstruction[10] and influence other receptors to reduce pain perception. Lundeberg[20] reported a significant reduction in myofascial and musculoskeletal pain compared to aspirin or transcutaneous electrical nerve stimulation. Therefore, if VT can increase pain threshold, the joint position at which pain is sensed may also increase, which further supports the early use of VT.

Proceeding any rehabilitation exercises requires an adequate warm-up of the injured muscle that reduces viscous resistance and allows warm muscles to absorb greater energy to withstand loading[21]. It has been documented that vibration is an effective warm-up that increases muscle temperature[5] to enhance muscle elasticity. In the current case study, static stretching of the triceps surae was immediately performed after VT. It is plausible that combining the warm-up of VT with stretching further improved muscle elasticity to resist a new tear of the injured muscle[21] where stretching is to able to distend the maturing scar[22].

In conclusion, the athlete reported no side effects of VT and its ease and time efficient application may play an important role to complementing soft tissue injury rehabilitation. However, future research should focus on randomised-controlled studies to evaluate physiological measures to determining VT efficacy in soft tissue rehabilitation.

Conflict of interest

None.

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