

# Slacklining for Lower Extremity Rehabilitation and Injury Prevention

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Slacklining can be defined as standing or moving on a tightened band,<sup>1</sup> while maintaining postural balance.<sup>2</sup> Originally developed by climbers as a leisure activity, slacklining has become a competitive activity. Performance of the task requires (1) integration of sensory input and neuromuscular response,<sup>3</sup> (2) balance (i.e., maintenance of the body center

of mass over the base of support),<sup>2</sup> (3) postural control (i.e., positioning of the body in space)<sup>1,4</sup> and (4) muscle strength.<sup>5</sup>

The motor learning process involved in becoming proficient in slacklining involves 3 phases.<sup>6,7</sup> The **cognitive** phase involves rejection of ineffective strategies and adoption of effective strategies,

which usually produces rapid improvement. The **associative** phase lasts for weeks to months, during which skills are acquired and consolidated, and performance consistency improves. The **autonomous** phase lasts for months to years, during which skills can be executed without conscious effort.

This motor learning process leads to improved control of the natural oscillations that occur when standing on an unstable

suspended strap, which is believed to occur through a presynaptic mechanism that decreases motor neuron excitability.<sup>1</sup> However, the suppression of reflexive muscle activation to mediate postural oscillations and avoid loss of balance during slacklining may actually be detrimental to maintenance of balance in other situations. Movements that are performed quickly and subconsciously require greater reliance on stored motor programming (i.e., open-loop control), whereas some activities allow for an action to be modified during performance (i.e., closed-loop control).<sup>3,4</sup> Each individual develops optimal response strategies to maintain balance during the performance of various dynamic tasks, which may be specific to the nature of the task.<sup>5</sup>

Slacklining recently was brought to the attention of a mass audience during the 2012 Super Bowl halftime show.<sup>8</sup> Slacklining primarily has been viewed as a leisure activity, but it has been used as a novel means to facilitate improvements in balance and proprioception.<sup>9</sup> Athletic trainers and therapists (ATs) should monitor a patient's progression through the sequential stages of motor learning, from the novice to the accomplished stage, when using slacklining in a clinical setting. Standardization of the methods used to promote the motor learning process can promote the safe and effective use of slacklining as a rehabilitation activity.

## KEY POINTS

▶ Slacklining is an emerging method for integrated training of interrelated performance capabilities.

▶ Slacklining can be readily incorporated into rehabilitation and injury prevention programs.

▶ A 4-stage protocol is proposed for training progression.

This report outlines a 4-stage protocol that consists of 20 steps for progression of slackline training in a clinical setting. Two case examples are used to illustrate progression through the protocol with functional outcome tracking documented by a web-based system (Advise Rehab, Coolum Beach, QLD, Australia).<sup>10</sup>

## Slackline Program Progression

Difficulty levels for any new training activity or rehabilitation method must be graded and progressive. Each step

in the progression should present a more demanding task.<sup>11</sup> Patients will not progress at the same rate; some may be able to skip steps in moving to a higher level of difficulty, and some may regress to a lower level of difficulty to consolidate a learned skill.<sup>6</sup> However, each step should be performed in sequence to progress through the 4 stages. Initially, slacklining should be performed on a band (e.g., nylon or polyester webbing) that is suspended only a few centimeters above a soft surface, such as grass or sand. The proposed 4 stages of basic slackline training and 2 advanced stages are outlined in Table 1.

**TABLE 1. SLACKLINE – QUANTIFIED 4 STAGES, 20 STEPS**

Stage and Steps	Position
Stage 1—Beginner: Stand	
1	Single leg stand — dominant
2	Single leg stand — nondominant
3	Single leg dominant and touch behind
4	Single leg nondominant and touch front
5	Single leg nondominant and touch behind
6	Single leg dominant and touch front
Stage 2—Moderate: Walk	
1	Walk forward
2	Walk back
3	Tandem stance dominant back
4	Tandem stance dominant forward
Stage 3—Intermediate: Tandem	
1	Tandem stance: turn on two feet to natural side with nondominant forward
2	Tandem stance: turn on two feet to non-natural side with nondominant forward
3	Tandem stance: turn on two feet to natural side with dominant forward
4	Tandem stance: turn on two feet to non-natural side with dominant forward
5	Side stand surf posture with feet perpendicular to the slackline
Stage 4—Advanced: Squats	
1	Surfer: Squat in side stand
2	Squat in tandem dominant behind
3	Squat in tandem dominant front
4	Single leg squat on dominant
5	Single leg squat on nondominant
Stage 5—Extreme	Without using arms. Without sight. Bouncing
Stage 6—Tricks: Jumps Flips	Heel raises, walking on toes, jumps, spins, somersaults on line or as dismounts. External focus (e.g., throwing ball, juggling ball) Surging (on very slack line) with oscillations and height perpendicular to the line

Slackline length and tension can be changed to modify the difficulty level.

## Slacklining Progressive Competency: 4 Stages and 20 Steps

The following text explains the characteristics of each stage of slackline training. To view 10 photos of these stages in various steps, visit the online version of this article.

Stage 1 is designated as the *beginner* or *standing* stage, which consists of 6 steps. Each of the steps involves single-leg standing. Initially, the dominant or unaffected extremity is weight-bearing, which is followed by single-leg support on the nondominant extremity. Subsequent steps involve primary weight-bearing on one extremity while the foot of the other extremity lightly touches the strap, with alternate positioning of the lightly touching foot in front of the weight-bearing foot and behind it.

Stage 2 is designated as the *moderate* or *walking* stage, which consists of 4 steps. This is initiated by walking forward, then walking backward. The activity is then progressed to stationary balancing in the Tandem position, which is alternately performed with the dominant and nondominant extremities in the forward versus behind positions.

Stage 3 is designated as the *intermediate* or *tandem* stage, which consists of 5 steps. The steps progress from the static Tandem position to turning the body in each direction, with the feet remaining in contact with the strap, and standing in the Surfer position.

Stage 4 is designated as the *advanced* or *squats* stage, which consists of 5 steps that progressively

add vertical movement of the body mass. Initially, bilateral squats are performed in the surfer position, and are subsequently performed in the tandem position. The positions of the dominant then non-dominant extremities are alternated in the tandem position. The final steps involve performance of single-leg squats on the dominant and nondominant extremities.

Stage 5 is designated as the *extreme* stage, which does not involve specific steps. Individualized progressions include eliminating use of the arms for balance (i.e., placing the hands on the hips, behind the back, on the head, or over the head) and closing the eyes. Further progression involves the addition of a bouncing action with the hands in various positions and with the eyes closed.

Stage 6 is designated as the *tricks* or *performance* stage, which may include ball juggling, 2-person activities, dance movements, or lateral swinging (i.e., 'surfing the line'). Other variations may include tip-toeing, walking on the toes, jumps, spins, and dismount somersaulting.

Each stage involves progressively more difficult steps, some of which may be skipped by some individuals. Progression to stages 5 and 6 requires imagination, skill, and extensive practice. Varying the length and tension of the line (i.e., strap) also alters the level of difficulty of each task.

## Case Studies

### Case Study I

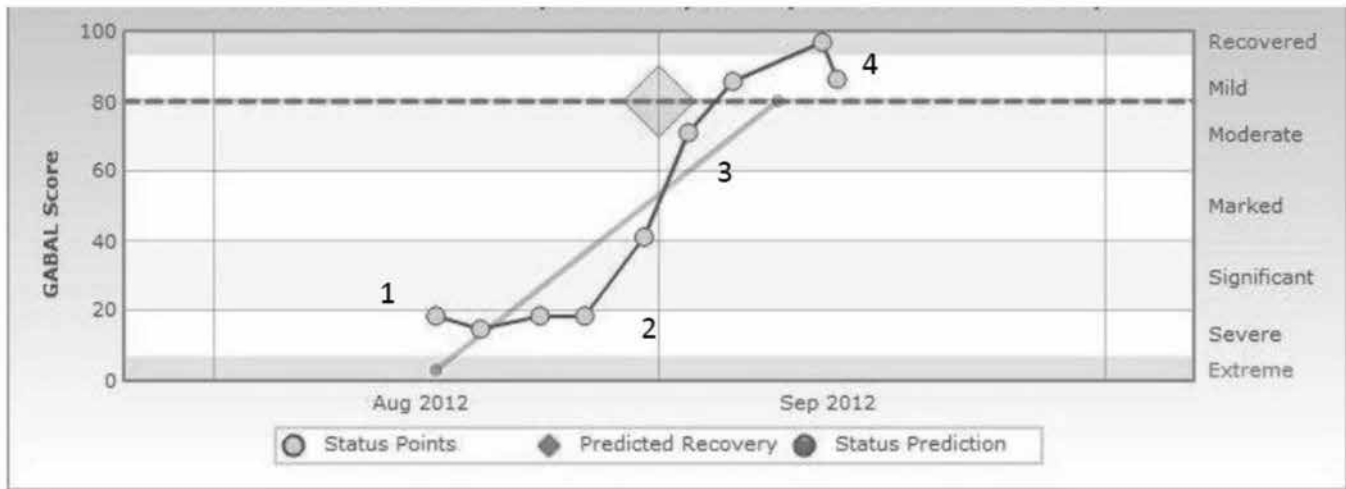
The patient was a 17-year-old elite surfer with a Grade 2 anterior talofibular ligament (ATFL) sprain (Figure 1). He sustained a plantar flexion and inversion injury that occurred when landing on a surfboard after completion of an 'Air 180' maneuver during training.

*Days 1-3 postinjury:* Clinical and radiological examination for confirmation of ATFL partial tear. Acute care included ice, rest, air compression boot, laser therapy, and electromodalities. On day 3 postinjury, partial weight-bearing was achieved and a graded rehabilitation program was initiated, which included active and passive movement, hydrotherapy, and resistive

strengthening exercises for eversion, inversion, and dorsiflexion.<sup>12</sup>

*Days 4-7 postinjury:* Full weight-bearing (FWB) was achieved, with taping for ankle stability. Rehabilitation was progressed to initiate passive mobilization, FWB balance training, weight-bearing dorsiflexion and plantar flexion, stretching, and concentric and eccentric strengthening. Self-directed slacklining (stage 1, steps 1-6) was initiated after instruction on day 5 postinjury (with the ankle taped). Supplementary self-directed slackline training sessions were conducted for 30–60 minutes each.

*Days 8-14 postinjury:* Physiotherapy sessions were conducted 3 times per week. Rehabilitation emphasized restoration of full passive and active range of



1. Days 1–11: Initial acute phase, transition from PWB to FWB, initiation of slacklining stages 1–2.
2. Days 12–14: Slacklining stage 3 started and return to water-based sports specific training.
3. Days 15–21: Slacklining stage 4 initiated and resumption of full intensity training.
4. Days 22–28: Slacklining stage 5 initiated and discharge from physiotherapy to self-management.

**Figure 1** Elite junior surfer ankle injury: functional outcome recovery pathway.

motion. Biofeedback training, electromodalities, and acupuncture were administered. Therapeutic exercises were performed at home. Gym-based rehabilitation was initiated on day 7 postinjury, which included strengthening exercises, dynamic balance activities, and cardiovascular conditioning. Stage 2 slacklining (steps 1-4) was completed on day 8 postinjury, and surfboard paddling on the ocean ‘popping’ to standing on a long board were initiated on day 9 postinjury. Stage 3 slacklining (steps 1-5) was completed on day 12 postinjury, and weight-bearing strength training volume was increased. Walk-run interval training was initiated on day 10 postinjury, which was progressed from hard sand to soft sand over a period of 4 days. Surfing difficulty was progressed through the introduction of competitive maneuvers and a reduction of board length to the use of a competition board by day 12 postinjury.

*Days 15-21 postinjury:* Stage 4 slacklining (steps 1-5) was performed from day 10 to day 21 postinjury. Physiotherapy sessions at a frequency of 3 times per week were continued.

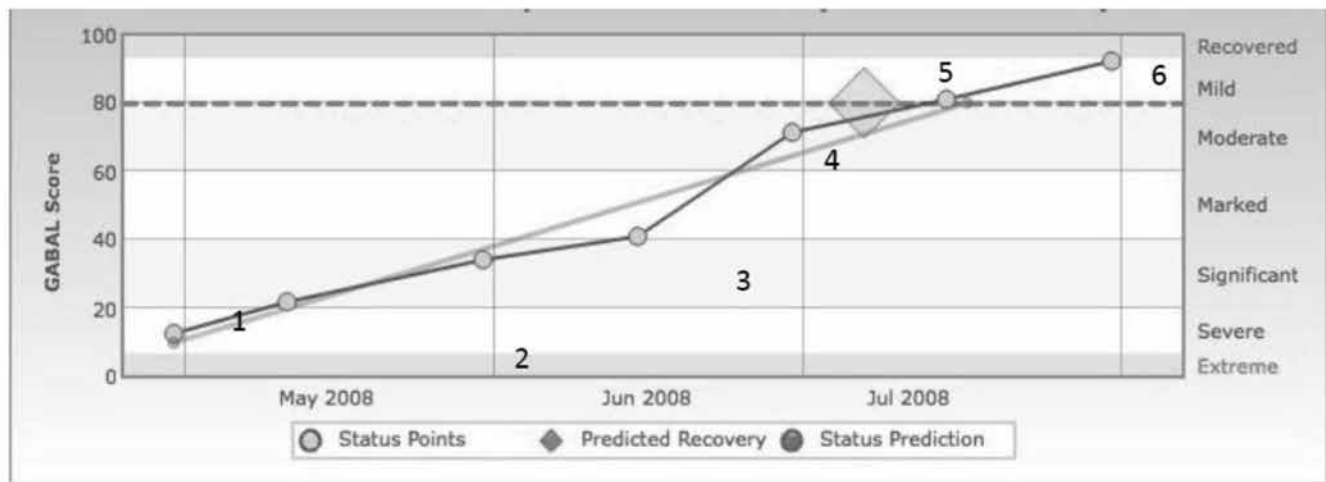
*Days 22-28 postinjury:* Unrestricted training was performed, with aerials (maneuvers performed when the surfer and the board are launched above the wave and there is no longer contact between the board and the wave’s water or foam surface) achieved on day

24 postinjury, and return to competition on day 35 postinjury. Slacklining extreme steps were initiated on day 20 postinjury, which included surfing, jumps, and spins. Physiotherapy sessions were reduced in frequency to 2 per week, and then once per week just prior to return to competition.

Compared to rehabilitation for previous ankle injuries, the athlete reported that slacklining had contributed substantially to an accelerated return to sport participation. Rapid improvement in physical capabilities was attributed to the self-motivating and fun aspects of slacklining. The athlete continued to perform slackline training and pre-competition ‘tuning’ through slackline activities.

### Case Study 2

The patient was a 23-year-old recreational soccer player with nonspecific knee pain and hypermobility (Figure 2). Intra-articular swelling, loss of range of motion, and inability to run were exhibited following participation in a soccer game. Orthopedic clinical evaluation, MRI, and arthroscopy were all inconclusive with regard to specific knee pathology. A diagnosis of hypermobility was based on a 7/9 Beighton-Scale hypermobility score (i.e., bilateral laxity apparent in multiple lower extremity joints), a history of recurrent ankle sprains, and surgical removal of loose bodies from the knee.



1. Weeks 1–3: Initial acute phase, transition from PWB to FWB, initiation of physiotherapy and rehab.
2. Weeks 4–6: Graded return to running, introduction to sports specific activity.
3. Week 7: Slacklining stages 1–2 initiated, concurrent rehab reduced, discharge from physiotherapy.
4. Week 8: Slacklining stage 3 initiated, running with directional change performed with confidence.
5. Weeks 9–10: Slacklining stage 4 initiated and return to noncompetitive sports.
6. Weeks 11–16: Slacklining stage 5 initiated and full resumption of recreational sports and activity.

**Figure 2** Recreational soccer player: functional outcome recovery pathway.

*Weeks 1–3 postsurgery:* Physiotherapy consisted of administration of electromodalities and compression, and weight-bearing was limited due to pain and swelling. Hip, knee, and ankle range of motion exercises, unilateral postural balance training, and strengthening exercises for the quadriceps, gluteals, core, and calf muscles were initiated.

*Weeks 4–6 postsurgery:* A gradual return to running was initiated, and continuous running for a duration of 30 mins was achieved. The patient exhibited a limited capacity for directional change, but he lacked confidence in the ability to perform rapid directional change or to return to participation in soccer.

*Week 7 postsurgery:* Stages 1 and 2 slacklining activities were introduced. Physiotherapy sessions were terminated, but self-directed rehabilitation activities and running (including directional changes) were continued.

*Week 8 postsurgery:* Stage 3 slacklining (Steps 1-5) were initiated and proficiency was achieved. Running was continued, and the patient's confidence in performance of rapid movements and directional changes increased.

*Weeks 9–10 postsurgery:* Stage 4 slacklining (Steps 1-5) were initiated, and proficiency was achieved. Participation in noncompetitive soccer and tennis was initiated at a low level of intensity.

*Weeks 11-16 postsurgery:* Stage 5 extreme slacklining was initiated, and participation in noncompetitive soccer and tennis was gradually increased to a normal level of intensity. Other activities included snowboarding, surfing, and trail running. The extreme slacklining included bilateral and unilateral standing with closed eyes, jumps, movement from standing to sitting through bilateral and unilateral squatting with perpendicular and parallel foot positions on the strap, V-sitting, lying, and movement from standing to each position and back to standing.

Return to full participation in soccer was achieved. Compared to a previous rehabilitation experience that followed an ankle surgery, the athlete felt that slacklining accelerated the process. The athlete continued to perform slacklining activities for training and recreation.

Both athletes felt that slacklining was an effective rehabilitation activity, which is low-risk, fun, challeng-

ing, self-motivating and portable. Perceived benefits included improvement in balance, body position awareness, and core strength. The 4-stage protocol for progression of slackline activities was found to be effective. When incorporated into a rehabilitation program, the slacklining protocol provided a systematic approach for progression to activities of increasing difficulty that built upon previously developed skills. The favorable outcomes achieved in both cases are illustrated by their respective progress charts (see Figures 1 and 2).

## Discussion

Injury prevention and rehabilitation programs should be designed to address performance deficiencies that are associated with elevated injury risk.<sup>13</sup> Some population subgroups have been identified as having a high level of risk for specific types of injury.<sup>14</sup> Contributors to injury risk include impaired postural control, poor neuromuscular coordination, and muscle weakness. An activity that simultaneously addresses all 3 of these injury risk factors through a self-directed training process should be incorporated into lower extremity injury rehabilitation, as well as training programs for performance enhancement and injury prevention.<sup>5</sup> Slacklining provides an integrated approach to improvement of functional capabilities in a safe, efficient, and cost-effective manner.

Although slacklining skill is retained to some extent after training, it requires regular practice to be maintained at a high level.<sup>5</sup> There appears to be an optimal 'band-tension' for maintaining balance with minimal effort.<sup>3</sup> Increasingly skilled slacklining performance is primarily attributable to improvements in balance that result from progressively more challenging activities,<sup>5</sup> which appears to coincide with a reduction in reflexive muscle responses that tend to produce oscillations.<sup>1</sup> Descending commands from the cerebral cortex are believed to produce presynaptic inhibition of reflexive muscle responses, which results in suppression of body oscillations that would otherwise lead to loss of balance.<sup>1,5</sup> This training adaptation may or may not have an advantageous effect on maintenance of dynamic joint stability when performing sport-specific skills on a stable playing surface.

Slacklining represents a novel approach to rehabilitation that is consistent with a whole-body perspective.<sup>15</sup> Consequently, slacklining is likely to become

an accepted rehabilitation method as further research establishes its benefits.

## Conclusion

Slacklining represents a novel rehabilitation and training method that can be readily incorporated into existing programs. A 4-stage protocol has been provided to standardize the process of progressing individuals from basic to advanced slacklining activities. ■

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