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CHATTANOOGA®

Treatment Strategy for Skiing Injuries Advanced Therapeutic Approaches

Bernard Bonthoux has always been closely involved in the world of sport.

After graduating from the UFR STAPS in Grenoble, he trained in physiotherapy and then osteopathy, driven by a desire to offer athletes comprehensive and rigorous support. More than thirty years of practice have enabled him to refine his solid expertise, nourished by experience both in the clinic and in the field.

A mountain enthusiast, he quickly joined the French Ski Federation as a physiotherapist and became involved in research and training. His clinical analyses and publications — notably in Profession Kiné and Vous Kiné (Professional therapy and self help therapy) — are now recognized for their accuracy and practical usefulness.

In 2020, Bernard further expanded his field of expertise by becoming an Enovis consultant for LightForce - Photobiomodulation therapy, a high-intensity laser (HILT). This new dimension reinforces his desire to combine innovation, therapeutic effectiveness and personalized support.

This ebook reflects this journey: an accessible and engaging summary, designed to share knowledge, shed light on practice and convey a passionate vision of care.

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THE SKIING PATIENT: INJURY STATISTICS AND PROFILES

Skiing is an increasingly popular and diverse activity combining downhill skiing, cross-country skiing, snowboarding, and freestyle skiing. The playing field has also changed significantly, moving from “bumpy” slopes to “boulevards” with increasingly steep gradients and therefore higher speeds, leading to a sharp increase in injuries.

The study on winter sports accidents, conducted each year by Médecins de Montagne (Epidemiological Network for the Observation of Winter Sports Accidents, 2023-2024 season report), provides telling figures:

Figures and incidence
The incidence of injury risk represents an average of 2.6 injuries per 1,000 skier-days.

Number of injuries
136,700 for the 2023-24 season across the French mountains. 83% of skiers and 13% of snowboarders, with an average age of 31.

Injury profile
40% sprains (mainly ACL) and 25% fractures.

Profile
Beginners on easy slopes are twice as likely to be injured, but the most serious injuries (head or spinal trauma) mainly occur on difficult slopes due to a combination of speed and lack of technical skill.

Periods
Injuries are also more frequent at the end of the day or at the end of a trip.

Professional skiers are also prone to overuse or muscle imbalance conditions such as patellar tendinopathy, lumbar spine pain, or Dorsalgia.

Faced with this growth in increasingly serious pathologies and impatient patients, it is important to review treatment methods and adapt practices to new technologies. More and more studies show that early treatment leads to better and more lasting recovery. The use of innovative therapies such as photobiomodulation, established therapies like shockwave therapy (ESWT), and proven therapies such as electrostimulation make this possible.

This e-book, dedicated to the three main pathologies affecting skiers, will allow us to consider different treatment methods. Then, importantly, to understand how to use and combine the various therapies available to us. Each intervention needs to be administered at a given time, depending on the presentation and the desired outcome. When interventions are combined, they accelerate treatment and reduce the failure rate. Of course, all these technologies will be used in combination with rehabilitation and manual therapy if necessary, under the supervision of a doctor or surgeon. Whether you are treating beginners, experienced skiers, or professionals, the approach remains the same: adaptation.

THREE COMMON PATHOLOGIES IN SKIERS:

Ultimately, three pathologies cover the main accident-related problems in both experienced and beginner skiers:

Acute: anterior cruciate ligament (ACL) rupture and its complications.

Chronic: tendinopathies (patellar tendinopathy) or repetitive strain injuries (spine).

	ACL	Patellar tendinopathies	Lower back pain
How the injury can occur / typical patient profile	Direct mechanism: Impact on the knee with the foot fixed to the ground, knee bent (flexed) and turned in (internally rotated) Indirect mechanism: Foot planted, knee caves in (knee valgus), hip rotates in (internal rotation), and the knee bends (flexes).	Tendon overload or repetitive strain	Position of the pelvis in relation to the skier's needs (pelvic retroversion) Profiles: Impact in beginners Overuse in poor postures with experienced skiers
Treatment difficulties	Arthrogenic Muscle Inhibition (AMI) Pain and swelling Restricted Range of motion (ROM)	Avoid complete stoppage / unwillingness to stop skiing	Beginner: weak muscle profiles Experienced: unwillingness to stop skiing/stopping them from skiing is a challenge
Potential secondary pathologies	Cyclops lesion Tendinopathies Re-rupture	General muscle imbalance	Low back pain Scheuermann's disease Compression

It is therefore important to seek treatment early on, and thanks to therapies such as photobiomodulation, shock waves, and electrostimulation, we are able to achieve superior results to standard physical therapy care.[32-34]

ACL RUPTURE

Anatomical overview:

The stability of this joint relies mainly on ligaments, which act as strong cords, but a more detailed description is important to understand the mechanisms of rupture and repair solutions.

There are two distinct functional bundles:

- The Anteromedial Bundle (AMB): Insertion at the posterosuperior part of the medial surface of the lateral femoral condyle (notch) and at the anterior and medial intercondylar area of the tibial plateau.
- The posterolateral bundle (PLB): Insertion at the anteroinferior part of the medial surface of the lateral femoral condyle and at the anterior and lateral intercondylar area of the tibial plateau.

Characteristics	AMB	PLB
Main role	Anterior translation brake	Rotation brake (Pivot-Shift)
Maximum tension	Knee flexed at approximately 90°	Knee extended at approximately 0°
Main clinical test (but NOT in isolation)	Anterior drawer (if no effusion splinting)	Lachman at 20 and 30° flexion

NB Anterior drawer test is unrealiable especially if the Posterior Cruciate ligament (PCL) is involved.

PATHOPHYSIOLOGY AND SKIING

Mechanisms	Detailed description	Commonly Affected Associated Structures
Valgus-External Rotation-Flexion (VALFE)	The knee is in forced valgus, external rotation of the tibia, and slight flexion. Most common mechanism. Often involves deceleration.	Unhappy Triad (O'Donoghue): ACL, Medial Collateral Ligament (MCL/LLI), Medial Meniscus (MM). Often involves a bucket-handle tear of the lateral meniscus (LM) following anterolateral subluxation.
Hyperextension	Pure hyperextension trauma, often due to contact.	May cause injury to the ACL, sometimes the PCL or posterolateral structures if the stress is severe.
Internal rotation torsion	Less common, but possible. Subjects the knee to rotational stress without major valgus.	ACL, then posterolateral structures.

ACL rupture is a major injury characterized by knee instability. It often occurs with an audible pop and is followed by rapid swelling (hemarthrosis). Consequently, the Anterior Drawer test needs to be done early.

Diagnosis

Clinical examination (Lachman, anterior drawer, pivot-shift tests) is essential, often supplemented by MRI to assess associated injuries (menisci, collateral ligaments).

Treatment

Treatment may be conservative (rehabilitation alone) or surgical (ACL reconstruction, most often using the medial hamstring tendon (MST) with external reinforcement). The decision depends on the patient's age, activity level, functional instability, and athletic expectations.

THE ROLE OF PHOTOBIOMODULATION (PBM)

Although ACL treatment is dominated by surgery and rehabilitation, PBM can play an important supporting role in the post-traumatic or post-surgical phase. It is involved in the management of pain, inflammation, optimization of ligament healing, and regeneration.

The main mechanism of action of PBM is the absorption of photons by Cytochrome C Oxidase (CCO), a key enzyme in the mitochondrial respiratory chain.[1] This stimulation increases ATP production: Activation of CCO increases the production of Adenosine Triphosphate (ATP), which boosts the cell's metabolic activity. Then, the release of nitric oxide (NO), an inhibitor of CCO, results in local vasodilation and improved microcirculation. Finally, the increase in ATP and NO activates transcription factors, modulating the expression of genes involved in cell proliferation, anti-inflammation, and the production of growth factors.[2]

Laser	Spot size (mm), Irradiance (Power density mW/cm^2), Fluence (Energy density J/cm^2)
Tissue	Chromophores (influence by light wavelengths)
Mechanisms	Photobiomodulation (light modifying cellular activity)
Effects	Physiological changes and therapeutic effects (expedites healing and pain relief)

The use of PBM can be divided into two clinical scenarios

A. Conservative Treatment and Acute Phase (Post-Trauma)

PBM will be used to control immediate symptoms and prepare the tissue for healing (in the case of stable partial injury) or surgery (emergency surgery is generally only performed on high-level athletes).

Anti-inflammatory action: By modulating the production of pro-inflammatory cytokines (e.g., IL-1, IL-6, and TNF-α) and increasing anti-inflammatory factors, PBM reduces oedema.[3]

Analgesic action: It acts directly on nocioceptors (nerve conduction) and reduces the production of pain mediators, contributing to non-pharmacological pain management.[4]

B. Post-operative (ligamentoplasty)

The main interest for surgeons and physical therapists is the potential impact on graft healing and early rehabilitation.

PBM optimizes graft take up: It stimulates fibroblast proliferation and type I collagen synthesis (the main collagen component of the ACL and the graft). This accelerates the critical phase of revascularization and remodeling of the graft .[5]

Action on post-operative pain: Facilitating better pain management accelerates recovery of range of motion (ROM).[35]

Main objective	Clinical Phase	Recommended Dosage (Indicative)	Frequency/ Duration	Area of Application
Analgesic & Anti-oedema	Acute Phase (Immediate Post-Traumatic or Early Post-Operative Days 1 to 7)	Low/Moderate Fluence (energy density) (2 to 6 J/cm^2)	Daily	Along the edges of the incision and around the effusion /oedema.
Graft Optimization & Healing[5]	Early/Middle Phase (from D7/21)	Moderate Fluence of 6-10 J/cm^2	3 times/week.	On the reconstructed tendon/ligament (healing), graft harvest site. Knee flexed at 90°

ESWT (EXTRACORPOREAL SHOCK WAVE THERAPY)

In the case of an acute injury such as ACL rupture, ESWT is rarely the first line of treatment for the ligament injury itself. The priority is stabilisation or surgery. However, some recent studies show that Extracorporeal Shock Wave Therapy can be used in combination with physical therapy following ACL ligamentoplasty:

Either immediately after surgery (day 2 post-op)

Low-power Radial Shockwave Therapy (RSWT) around the patella, plus 10 cm above the patella, thus avoiding the surgical area, at a rate of one session per week for 6 weeks to improve function, pain, and daily activities (Song et al 2024).[6]

Or in delayed post-op (6 or 8 weeks post-op):

Low-energy RSWT or FSWT on the joint center, femoral tunnel, and tibial tunnel to improve ACLR graft maturation at two-year follow up. [27-28] Another study also showed a faster return to running and pivoting activities, which would be beneficial to skiiers (Weninger et al 2023).[7]

Earlier studies demonstrated the effectiveness of ESWT following ligamentoplasty for:

- Pain or fibrosis in the Hamstring graft site at the Tendon Bone Insertion (TBI)
- On the Patellar tendon, if there is residual tendinopathy following a Bone tendon Bone graft (Savalli et al 2003).[8]

NEUROMUSCULAR ELECTROSTIMULATION (NMES)

NMES is used in the first few weeks after ACL surgery or trauma to combat Arthogenic Muscle Inhibition (AMI). Recent studies have also shown significant benefits of NMES for the Leg Symmetry Index (LSI), an important marker for return to training (>90%). The most benefit coming when it is combined with visualisation, motor reprogramming, proprioception and muscle strengthing exercises, especially during the transition from physical therapist to physical trainer (Labanca et al 2022).[10]

The combination of NMES and resistance exercise has also been shown to be beneficial for treating patella tendinopathies (Labanca et al 2022).[11]

Use of cryotherapy

First, the RICE will be implemented, including the use of Compressive Cryotherapy (Knee Universal Excell Ice DonJoy®). This is the gold standard method for immediate post-operative care. It combines the effect of cold with intermittent or static pressure. The advantage of adding compression is that it is significantly more effective for draining effusion and oedema than cold alone, improving patient satisfaction and functional recovery. Standard recommendations include regular and repeated applications, often 3 times a day for 20 to 30 minutes, especially during the first 10 to 15 days. During rehabilitation sessions, the therapist will use it just before and/or after the sessions, as pain and oedema tend to increase after exercise.

Given the choice, Photobiomodulation therapy (PBMT) should be prioritized over cryotherapy due to its broader and more effective range of action (Fisher et al 2019).[12]

Rehabilitation exercises

Rehabilitation is essential: it aims to quickly restore full joint range of motion, particularly extension, which is essential for normal walking and the prevention of arthrofibrosis. Early rehabilitation includes gentle passive and active mobilization, followed by strength training, proprioception, and specific return to sport exercises.[13]

SURGERY OR NOT?

Studies emphasize the importance of a "tailor-made" approach (Fithian et al 2005)[14] adapting the choice of graft and technique to the patient's characteristics and level of risk. Post-operative rehabilitation is lengthy (often 6 to 9 months before returning to pivoting activities). In high-level skiing, a return to competition is recommended after 1 year.

This issue can often be summarized by two points: athlete or non-athlete? Stability or instability in everyday life or sports?

For high-level skiers, young athletes, or in cases of major rotational laxity (grade 2 or 3 on the Pivot-Shift test), it is increasingly recommended to combine intra-articular reconstruction with anterolateralplasty (ALP) or extra-articular tenodesis (e.g., Lemaire type on the fascia lata). This is currently the most commonly performed surgery for high-level skiers. The objective is to control anterolateral instability (resort or pivot-shift), which is particularly affected by torsional stresses during skiing (new ski characteristics, edge changes, jump landings, heavy snow). This ACL+ PCL combination is often recommended for people at high risk of recurrence, including young athletes (< 25 years old) who participate in pivot-contact sports.

WEARING A SPLINT

Contrary to some health beliefs, wearing a splint is essential and progressive. Splints are essential as a first step to stabilise the joint, improve proprioceptive awareness and then, depending on progress, to facilitate rehabilitation and return to sport.

Different types of braces depending on whether surgery has been performed and the stage of injury progression:

Unoperated ACL	Recommended type of brace	Objective	
Acute phase	Immobilization splint or locked articulated splint	Rest the joint, control swelling and pain. It should be worn for as little time as possible and removed during rehabilitation sessions.	 Support Everest II
Rehabilitation phase Return to sports	Rigid functional ligament brace	Compensates for the absence of the ACL to stabilise the knee when walking, during daily activities, and especially during specific physical or sporting activities.	 ACL Everyday

ACL surgery	Recommended brace	Objective	
Immediately post-operative (D1 to D7/21)	Postoperative articulated splint	Protection of the graft against excessive movement and control of range of motion (ROM). Often worn when walking with crutches for pain relief.	 Support Everest II Ice
Early phase (D7 to D15/30)	Articulated splint	Used for walking outdoors and sometimes at night for pain relief or to prevent incorrect movements.	 Support Everest II Ice
Rehabilitation Return to athletics Return to sport	Flexible knee brace or no brace	Unless otherwise advised by the surgeon (slow healing, residual laxity), the brace is often abandoned in favor of muscle strengthening, which becomes the main dynamic stabilization of the knee.	

PATELLAR TENDINOPATHIES

Anatomical overview

Patellar tendinopathy (or jumper's knee) is a chronic overload condition of the patellar tendon, characterised by pain located just below the patella. The main cause of tendinopathy in skiers, is caused by significant knee flexion (eccentric traction) due to maintaining the skier's posture.

Pathophysiology and skiing

Unlike classic inflammation (tendinitis), this condition involves tissue disorganisation (tendinosis), with abnormal cell proliferation and neovascularisation, often without acute inflammation. This occurs in a tendon composed mainly of type I collagen bundles.

Several areas can be distinguished (Cook and Purdam classification, 2009):[15]

- Main area of involvement: The lesion is located predominantly at the lower pole (apex) of the patella, in the area where the tendon attaches (osteotendinous junction).
- Critical treatment area: Often the proximal and posterior portion of the patellar tendon (adjacent to the patella).
- Tendon and microtrauma: The pathological area typically presents with: disorganisation of collagen fibers, hypervascularization (pathological neovascularization), infiltration by fibroblasts and an absence of classic inflammatory cells (hence the term tendinosis).

Phase	Description of Pain	Functional consequence
Phase 1	Pain only after activity.	No limitation of performance.
Phase 2	Pain at the start of activity, disappears when warmed up, and reappears afterwards.	Able to participate in activity, but with discomfort.
Phase 3	Pain during and after activity. Performance is limited.	Significant reduction in training or competition load.
Phase 4	Constant pain (even during daily activities) and possible tendon rupture.	Complete cessation of sporting activity.

TREATMENT

Treatment is mainly conservative and focused on rehabilitation to restore the tendon's ability to tolerate load. This rehabilitation will be enhanced by Photobiomodulation (PBM) and/or ESWT.

The role of photobiomodulation (PBM):

PBM has proven to be very effective in the management of tendinopathies. In order to promote collagen organisation, a contact head could assist, to be applied in the direction of the fibres.

The most firmly established benefit, directly linked to the mechanism of action is on Cytochrome C Oxidase (CCO)

Pain reduction: PBM is used to rapidly reduce pain during acute or exacerbation phases (Cook and Purdam, Phase 2 or 3). By inhibiting nerve conduction and modulating pain mediators, it creates a crucial therapeutic window. The clinical benefit is that a less painful tendon is a tendon that can be loaded more effectively and earlier (optimal loading), thus accelerating the transition to the strengthening phases.

Inflammation control (tissue reaction): Although tendinopathy is tendinosis (degeneration) and not tendinitis (classic inflammation), there is a local inflammatory and metabolic reaction. PBM helps modulate this reaction and reduce oedema (tendon thickening often seen on ultrasound).

Main objective	Phase of Tendinopathy (Cook and Purdam)	Recommended Dosage (Indicative)	Frequency/ Duration	Area of Application
Hypoalgesia and Therapeutic Window	Stages 2 and 3 (Pain limiting exercise)	Moderate (4 to 8 J/cm^2)	3 times/week, just before strengthening exercises.	Lower pole of the patella and painful area of the tendon.
Tissue remodeling & collagen	Phases 1 and 2 (Progressive loading phase)	Moderate (6 to 12 J/cm^2) Strong on quadriceps (15 to 20 J/cm^2)	2 to 3 times/week.	Targets the proximal and posterior portion of the patellar tendon (critical area). Don't forget the quadriceps
Neovascularization	Chronic and refractory cases	Moderate to high (8 to 15 J/cm^2)	Twice a week.	The tendon, to improve nutrient supply

Stimulation of fibroblasts and collagen: The increase in ATP stimulates the proliferation of tenocytes (tendon cells) and improves the production and organization of type I collagen. The aim is to improve the quality of the tendon matrix by accelerating the degenerative remodeling process towards a healthier and more resistant matrix.[16]

Improved microcirculation: PBM-induced NO release promotes local vasodilation, improving nutrient supply and metabolic waste elimination in the tendon, a naturally poorly vascularized structure.

EXTRACORPOREAL SHOCKWAVE THERAPY (ESWT):

ESWT is the treatment option of choice for chronic refractory tendinopathies. Low-energy radial shock wave therapy (ESWT) is recognized for its effectiveness. It works by stimulating tissue healing and neoangiogenesis (the formation of new blood vessels) in the injured area, while also providing pain relief.

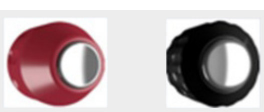
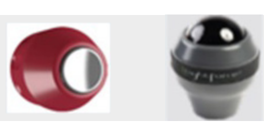
Both radial shockwave therapy (RSWT) and focused shockwave therapy (FSWT) have proven effective in treating patellar tendinopathy [17], especially when combined with eccentric exercises. [18]

In cases of stubborn patellar tendinopathy, the combination of PRP and ESWT has proven effective (Jhan et al 2024). [19]

Neuromuscular Electrostimulation (NMES)

NMES can be used to strengthen the quadriceps without placing excessive strain on the tendon during very painful phases. Combined with active exercise the muscles are worked hard but not overloading the tendon. For better exercise recovery low frequency programmes (8Hz), like Capillarisation on the Chattanooga and Compex devices, are recommended. The research has shown that combining NMES with active exercise, throughout the rehabilitation process, provides superior results than using exercise alone. [29-31]

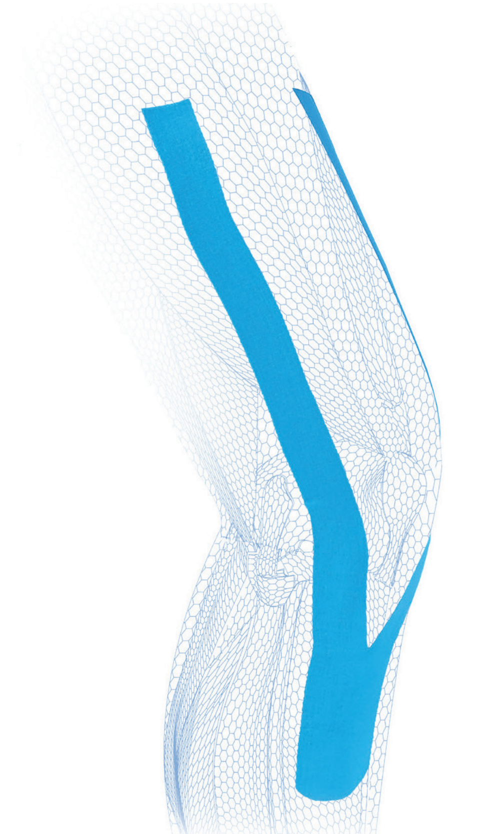
Patella teninopathy management summary

Modality	Acute pain and inflammation	Tissue healing	Stengthening and recovery
 PBMT (LFT)	Pain from day 1 Anti-Inflammation from day 2-3	Daily first week from day 2-3	Post exercise to Quadriceps
Transmitter			
 ESWT (FSW/RSW)	Prom-inflammation from day 1 plus Myofascial Trigger Points	1 x ESWT/week Combine daily with PBMT from day 2-3 post ESWT	Post exercise to Quadriceps
Transmitter			
 NMES (WPro)	TENS x 2-3 daily for pain Capillarisation (5Hz) on Quads with cold compression on knee	Capillarisation (5Hz) on Quads x 2 daily	Disuse atrophy x 2/day isometric hold progress to resistance combined with active exercise

Taping or rigid bandaging (McConnell/Mulligan)

Essential for this type of condition, taping should be used as soon as the condition is discovered. Different techniques are required depending on the desired effect, including neurosensory effects, improved proprioception, lymphatic drainage, reduction of oedema, and finally muscle support. Application is recommended for stage 1 or 2 tendinopathies.

Rigid tapes can be used to correct Patellar mal-tracking. Although patellar tendinopathy is a condition caused by tendon overload, it is often associated with an alteration in the femoropatella alignment (mal-tracking), which can increase stress on the patellar tendon. This type of tape should be applied after a postural assessment and is more suitable for stage 3 or 4 tendinopathy.



The clinical effects of ESWT

Mechanotransduction, which has been defined as: the conversion of mechanical forces into cellular signals that trigger specific responses.[26] The significance of mechanotransduction lies in its ability to regulate various cellular processes, including cell growth, differentiation, migration, and survival.

It was believed, in the past, that tendons could not undergo matrix turnover and that tenocytes were not capable of repair. However, it has been shown more recently that Matrix Metallo Proteinases (MMPs) have a very important role in the degradation and remodeling of the ECM during the healing process. A human in-vivo study[9] demonstrated the association between IL-6 and collagen synthesis, and the IL-8 cascade, which encourages neutrophils to release ECM-degrading and remodelling enzymes (MMPs), resulting in a minimum 5-fold increase in MMP production at any point post-ESWT.

USE OF CRYOTHERAPY

The use of specific cryotherapy splints will complement the treatment. This is an excellent pain management tool that helps optimize compliance and the effectiveness of the progressive optimal loading program. If pain is a factor limiting the patient's ability to achieve the load required for mechanotransduction, cold analgesia is a valuable tool for optimizing the quality and intensity of exercise. Compressive cryotherapy or simply direct icing can be used.

Rehabilitation

First, the isometric loading protocol is implemented: use of high-intensity isometric contraction. This is an essential tool in the initial phase of pain management for patellar tendinopathy. Its main objective is to induce immediate hypoalgesia to create a "therapeutic window" allowing progression to more demanding strengthening exercises.

Next comes eccentric muscle work (muscle contraction associated with elongation) or Heavy Slow Loads (Concentric/eccentric contractions), which are standard for the treatment of tendinopathies. Specific protocols, such as single leg decline squats, have been shown to be effective in selectively increasing the load on the patellar tendon. It is crucial that this work be done gradually and below the pain threshold to stimulate tissue healing without aggravating it. If the tendinitis only occurs at certain degrees of flexion, it will be necessary to work below or above these angles, avoiding pain.

Mobility and strengthening exercises are the cornerstone of treatment: in addition to the optimal loading strategy, core strengthening and proprioception work are essential to improve motor control and lower kinetic chain alignment in order to prevent recurrence.

SURGERY OR NOT?

Surgery is reserved for cases where conservative treatment, including injections (corticosteroids or PRP) and progressive reloading programs, have consistently failed (usually after 6 to 12 months of optimal care or depending on the ski season—spring is preferable in order to allow for a gradual recovery without the constraints of skiing).

The indication for surgery is primarily functional and symptomatic:

Failure of Conservative Treatment: Persistent chronic pain (Phase 3 or 4 of the Cook and Purdam classification)[15] ,despite a well-conducted rehabilitation program (optimal loading) lasting at least 6 months, often extended to 9-12 months.

Severe functional impact: Inability to return to previous athletic level and significant impact on activities of daily living.

Exclusion of differential diagnoses: Confirmation by imaging (MRI, ultrasound) that it is indeed tendinosis of the lower pole of the patellar, and not a cartilage lesion, patellofemoral pathology, or Osgood-Schlatter disease.

The different surgical procedures are:

Debridement and excision (open technique or arthroscopy), in which the area of degenerative tendon tissue (the neo-matrix) is removed, often located on the posterior and proximal side of the tendon (against the lower pole of the patella).

Tenotomy and drilling, which involves making a longitudinal incision in the tendon to stimulate an inflammatory response and neovascularization, thereby promoting healing. Then, drilling small tunnels in the bone of the lower pole of the patella allows blood and stem cells to flow to the injured osteotendinous junction, which is supposed to improve repair (localized microfracture effect).

Tendon stripping to cut small nerves (neo-innervation) and neovessels that are often associated with chronic pain.

In all these cases, PBM must be used immediately after surgery (daily from day 1 to day 5, then 2 to 3 times a week depending on rehabilitation). This type of treatment promotes microcirculation and fibroblast formation and stimulates stem cells.

LOW BACK PAIN AND PATHOLOGIES OF THE THORACOLUMBAR JUNCTION

Anatomical overview

In this anatomical overview, the key point is the correlation between the forces exerted and the skier's spine.

Segment	Description of Pain	Functional consequence
Thoracic spine (T1-T10)	Rigidity due to the costal joints. Orientation of the facet joints in the frontal plane.	Promotes rotation and lateral bending. Limits flexion/extension.
Thoracolumbar junction (T11-L2)	Transition of facet orientation (from frontal to sagittal).	Area of maximum shear and stress, as it must absorb the rotational movements of the thorax and the flexion/extension movements of the pelvis.
Lumbar spine (L3-L5)	Orientation of the facet joints in the sagittal plane.	Promotes flexion/extension. Limits rotation.

Key Muscles:

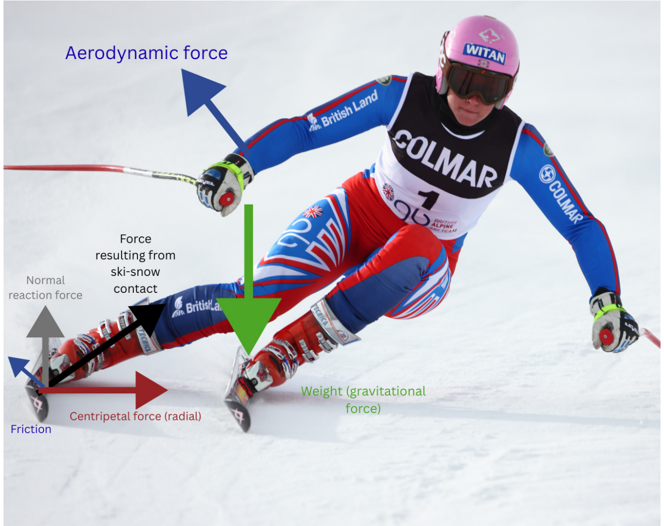
Iliopsoas (L1 to L5): It's shortening or spasm, common after prolonged hip flexion (an important position in skiing), increases lumbar lordosis and exerts anterior shear on the spine.

Spinal erectors (Longissimus and Ilio-Costal): They undergo constant eccentric work to maintain posture against gravity and vibrations (Whole-Body Vibrations), leading to fatigue and hypertonia.

STUDIES AND PATHOLOGIES RELATED TO SKIING

Spinal pain is often of non-specific common origin, i.e., without any identified serious injury. It results from muscle fatigue, overwork, poor posture during practice, or an imbalance between the stabilising muscles of the trunk.

Pathogenic factors in skiing: Unfavorable trunk kinematics – High ground reaction forces (over 3 G) – Vibrations. The vibration frequency (4 to 10 Hz) resonates with the spine. The bent position and the need to absorb shocks when skiing also place significant strain on the thoracolumbar or lumbar spine.



In non-competitive skiers, a lack of strength in the abdominal muscles and spine, as well as hip hypomobility, are major contributing factors.

Highlights Studies:

Studies have shown that 56% of high-level skiers suffer from thoracolumbar pathologies, with an average age of onset of 14.5 years, which is very young. What's more, 88% of these pathologies are due to skiing (Aavikko et al, 2025). [20]

ROLE OF PHOTOBIOMODULATION (PBM):

For this type of pain, PBM is a very useful modality because it combines several specific effects:

Immediate pain relief, which is very useful for high-level skiers suffering from muscle and joint pain. It helps reduce muscle spasms and local tissue inflammation. This action improves function because by reducing pain, it makes it easier for skiers to engage in strengthening and mobilisation exercises, which are key to long-term recovery.

The anti-inflammatory effect, which has been demonstrated and reduces dependence on anti-inflammatory drugs (Naterstad et al 2018).[21] The Cochrane Review has also evaluated PBM for the treatment of non-specific low back pain, suggesting an effect on pain (Yousefi-Nooraie et al 2017).[22]

Main objective	Phase of Low Back Pain	Recommended Dosage (Indicative)	Frequency/ Duration	Area of Application
Hypoalgesia Anti-inflammatory	Pain limiting exercise	Moderate (4 to 8 J/cm^2)	3 times/week, just before rehabilitation	Painful area of the spine at the vertebral level
Muscle relaxation	Transition phase between physiotherapy and return to sport	Strong (8 to 15 J/cm^2)	Depending on physical therapy or sports specific sessions	Paravertebral areas
Muscle preparation	Return to sport	Very strong (20 J/cm^2)	Before the session	Paravertebral areas and peripheral muscles

EXTRACORPOREAL SHOCKWAVE THERAPY (ESWT):

In the case of a minor condition, even if priority is given to active rehabilitation, combining it with shockwave therapy can quickly improve pain and function. All of this has been validated by numerous analyses and meta-analyses (Walewicz et al 2020).[23]

Neuromuscular Electrostimulation (NMES)

NMES can be used to facilitate awareness and strengthening of deep muscles (transverse abdominis, etc.) that are often hypoactive in patients with spinal disorders. [24] The use of biofeedback is very useful.

Rehabilitation

Mobility exercises focus on flexibility of the pelvis and hips (stretching the hip flexors, hamstrings, and psoas) and mobility of the spine to restore proper kinematics.

Core strengthening (plank, bird-dog) is the fundamental exercise for preventing recurrence of skiers' low back pain, as it stabilises the trunk against the stresses of the terrain. However, for professional athletes, it is essential to work on strengthening in the ski position. This involves positions that are harmful to the spine but essential for practicing this sport (Spörri et al 2019).[25]

Therapy	Specific Role in Spinal Treatment	Clinical Benefit
Photobiomodulation (PBM)	Immediate pain relief, reduction of muscle spasms and inflammation.	Facilitates patient engagement in strengthening exercises. Helps reduce dependence on anti-inflammatory drugs.
ESWT (Shock Waves)	Generally not a priority, except in cases of very specific myofascial trigger points.	Targets chronic contractures that do not re-spond to other treatments.
NMES	Facilitates awareness and strengthening of deep muscles.	Combats hypoactivity of stabilisers to prevent recurrence.
Rehabilitation	Basic core strengthening (plank, bird-dog) to stabilise the trunk. Work on flexibility of the pelvis and hips	Restores proper kinematics. It is essential for professionals to work on strengthening in the skiing position.

DIFFERENT TYPES OF SURGERY

The most common surgeries on the thoracolumbar and lumbar spine in these athletes mainly concern pathologies related to wear and tear (degenerative), and repeated mechanical stress, rather than acute traumatic fractures, which are less common. In high-level skiers, the spine is subjected to extreme stress, combining repeated flexion/extension, speed, forced rotations, and above all microtrauma (shocks and vibrations) that can occur thousands of times per season. The majority of surgical procedures aim to treat the consequences of chronic overload on the discs and vertebrae.

Herniated disc surgery is the most common procedure on the lumbar spine in athletes, allowing for faster recovery. Skiing places excessive strain on the intervertebral discs, and studies show that 85 to 90% of athletes can return to competition after successful herniated disc surgery.

Spondylolisthesis is mainly a condition that affects young skiers and athletes. It is often caused by spondylolysis (a vertebral stress fracture) due to repeated hyperextension and rotation. If spondylolysis becomes unstable, it progresses to spondylolisthesis. This phenomenon is caused by the "egg" position (speed position) in alpine skiing or violent landings after jumps that put a lot of strain on the lumbar extension. However, surgery is very rarely recommended as it is difficult to resume high-level skiing afterwards.

USE OF BELTS

Level of support	Pathologies and Indications	Type of skier	Characteristics/Objectives	
Light to Moderate (Flexible)	Prevention Mild chronic low back pain Occasional pain Re-suming activity after acute pain Use during long car or plane journeys	All levels, including beginners and intermediate riders (for prevention).	Basic support, thermal effect, freedom of movement maintained. Ideal for regular use or prevention for skiers who do not suffer from severe conditions.	 DonJoy Immostrap 2.0
Moderate to high (semi-rigid, with stays)	Acute low back pain, lumbago, sciatica and cruralgia, herniated disc (in the non-surgical phase).	Skiers with a history of pain or recovering from injury/surgery.	Strong compression and reinforced support Limits extreme movements to rest the spine and relieve pain.	 DonJoy Actistrap 2.0

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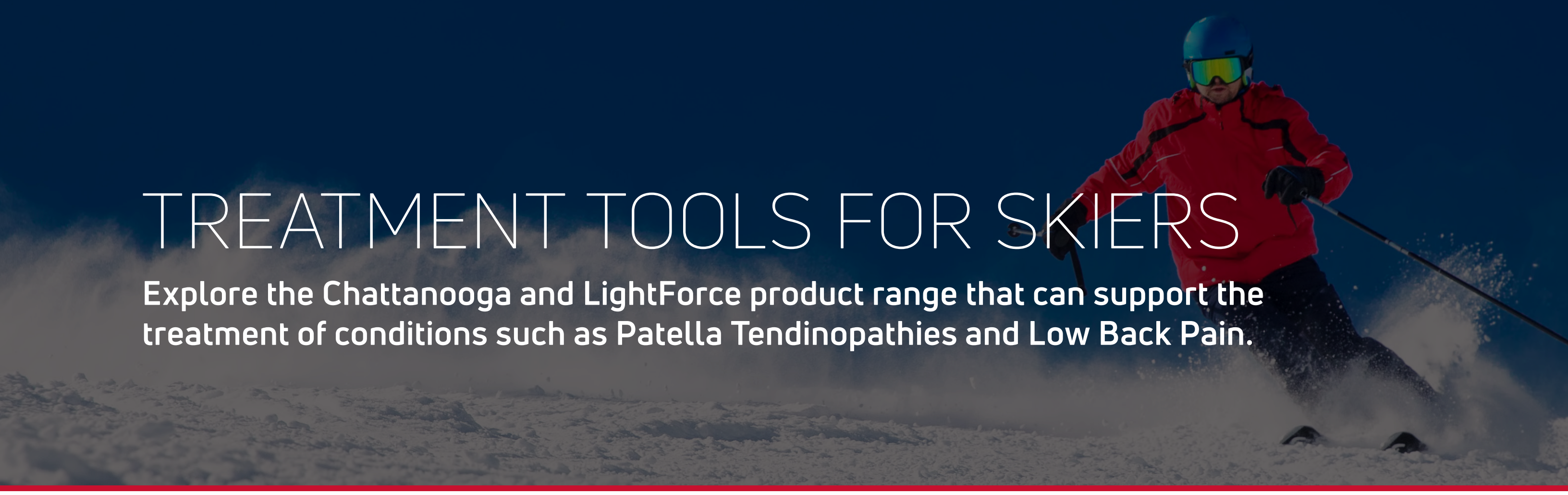

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