Surfing, More Than Just Riding a Wave: A Movement System Impairment Syndrome Approach to the Evaluation and Treatment of the Surfing Athlete

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ABSTRACT

Surfing is a rapidly growing sport enjoyed by both recreational and professional athletes. This monograph is intended to introduce the management of patients who surf. It primarily covers ocean surfing, but gained knowledge can be adapted to individuals surfing in wave pools and other bodies of water. The management of surfers as patients is quite complex. A clinician needs to consider the mechanism of injury, chronicity of symptoms, patient's skill level, biomechanics of the different phases of surfing, types of maneuvers on the board, equipment used, and the types of waves surfed to create an effective plan of care. This monograph details the incidence of surf-related injuries, signs and symptoms warranting a referral to other practitioners, the evaluation and diagnosis of surfers using a movement system impairments approach, and recommendations for rehabilitation to help surfers return to the water. This monograph discusses the biomechanics associated with each phase of surfing, some maneuvers that can be completed while surfing, the basics of surf equipment, and wave components. Four case studies at the end of this monograph give examples of incorporating the information from this reading to manage injured surfers. The case studies are of 3 recreational surfers with a neck injury, shoulder injury, and post-partum lumbar pain and 1 competitive surfer with an ankle injury.

Key Words: movement system impairment (MSI), phases of surfing and paddling, surfboard maneuvers, wave riding

LEARNING OBJECTIVES

Upon completion of this monograph, the course participant will be able to:

1. Report the incidence, prevalence, and etiology of common surf-related musculoskeletal injuries.
2. Diagnose significant surf-related musculoskeletal injuries and identify conditions warranting referral outside of physical therapy.
3. Describe the ideal surfer postures in various positions considering differing styles to make corrections to a patient's positioning on the surfboard.
4. Analyze the basic phases of paddling on the surfboard while on land and in the water to adjust surfers' biomechanics.
5. Analyze the pop-up movement on the surfboard to identify aberrant movement patterns that may need to be modified.
6. Describe the types of surf-specific maneuvers to incorporate them into plans of care.
7. Discuss surfer-specific history intake considerations to guide the evaluation and management of this population.
8. Recognize the most common impaired movement patterns seen in surfing athletes.
9. Implement a movement system impairment syndromes approach in assessing and managing surf-related injuries.
10. Develop a treatment plan for return to surfing based on the patient's internal and external factors.
11. Implement injury prevention and surf performance strategies for recreational and competitive surfers.

INTRODUCTION

The International Surfing Association (ISA) defines surfing as "shortboard, longboard, bodyboarding, standup paddle racing and surfing, para-surfing, bodysurfing, wakesurfing, and all other wave riding activities on any type of waves, and on flat water using wave riding equipment."[1] While surfing has expanded beyond waves formed in the ocean to inland waters such as rivers and wave pools, for the context of this monograph, the term 'surfing' will be limited to shortboard and longboard surfing styles in the ocean. It is left to the reader to use the knowledge gained from this monograph in evaluating and treating injuries from river or wave pool surfing.

The earliest known signs of surfing are believed to be from about 3000 years ago in Huanchaco, Peru, on *caballitos*. These were small fishing boats made up of bundled reeds. The fishermen took the caballitos into the open water and rode the waves into shore while straddling them.[2] Board surfing dates back to about 2000 years ago in Polynesia.[2] Hawaii was one of the main Polynesian island chains that perpetuated the surfing culture. The Polynesian people started surfing on flat pieces of wood.[2] Surfing in Polynesia was started as a means of recreation, unlike in Peru, where surfing started as a byproduct of work.

The growth of recreational surfing started in the early 1900s and was promoted by the likes of George Freeth and Duke Kahanamoku.[2] Competitive surfing gained traction and became more popular in the 1920s in Hawaii, Australia, and California.[2] Surfing continues to grow in popularity, and now 109 nations are members of the ISA. The countries with the highest recorded surfing sessions per year are, in descending order: Australia, the United States, Japan, Brazil, and Indonesia.[3]

In 2016, the International Olympic Committee decided to include surfing as a new sport in the Olympics; it eventually made its debut in 2021.[1] It is estimated that 35 to 37 million people participate in the sport worldwide, with 3.81 million participants in the United States.[1,4] The most popular surf locations in the United States are in Southern California: El

Porto, San Onofre, Huntington Beach, Bolsa Chica, and Trestles.[3] The estimated continued future growth of the sport is expected to be around 11.5% per year.[4]

Surfing is a sport with the potential for injuries, and the growth of the sport will lead to the need for healthcare professionals, such as physical therapists, to be versed in managing these individuals. The purpose of this monograph is to provide a synthesis of the literature on surfing-related musculoskeletal injuries, describe the components of surfing, present a model (primarily based on the movement system impairment [MSI] approach) to evaluate injured surfers, recommend treatment techniques, and review external factors that will affect recovery. This monograph is meant to introduce surfing, surfing-related injuries, and the rehabilitation of recreational and competitive surfers. Patient cases are provided as examples of how to apply the knowledge obtained from this document. A list of surfing terms and their definitions is in the **Appendix**.

EPIDEMIOLOGY AND ETIOLOGY OF INJURY

Individuals who participate in surfing are susceptible to injury. The probability of getting injured while surfing, in a 12-month period, for recreational, competitive, and aerialist skill levels is 30% to 35%, 41% to 42%, and 48%, respectively; beginner surfers have a 22.7% probability.[5,6] This represents approximately 1 out of every 3 recreational and 1 out of every 2 competitive surfers being injured every year.[5]

A systematic review by Bickley et al[7] found the incidence rate of injuries (total number of injuries per 1000 hours surfed) ranges between 1.1-13.0 for all levels of surfers. When broken down into skill levels, the incidence rate ranges from 2.18-2.33/1000 hours for recreational surfers, 1.51-2.11/1000 hours for competitive surfers, and 1.98/1000 hours for aerialists.[5,6]

Injuries from surfing can occur through gradual onset, such as repeated microtrauma without a known mechanism of injury (ie, overuse) or from trauma where there is an identifiable event that caused the injury.[8,9] Gradual-onset and traumatic musculoskeletal injuries are described in this monograph as acute (<3 months) or chronic (>3 months).

Gradual-Onset Mechanism

The most common causes of gradual-onset musculoskeletal injuries are paddling, approaching the wave, duck diving, and riding the wave.[8,9] The most common body locations injured are the shoulders, lower back, and neck, with paddling causing 40% of those injuries.[8–10] Gradual-onset shoulder injuries often occur at the rotator cuff and subacromial bursa.[9,10] A prolonged prone position was associated with 67% and 48% of the injuries at the neck and back, respectively.[8,9] The process of standing up from the prone position may contribute to low back pain.[9] Hip injuries occur most commonly while sitting on the board and may be related to 67% of those patients diagnosed with femoral-acetabular impingement (FAI).[5,11]

In rare cases, an individual may experience surfer's myelopathy, which presents as lower extremity pain, paresthesia, and possible paralysis.[7] This is primarily seen in beginner surfers, possibly from prolonged hyperextension of the lumbar spine leading to ischemia of the spinal cord. Recovery can take months and may not happen at all in more severe cases.[7]

Risk factors for gradual-onset injuries are using a longboard versus a shortboard, advanced age, completing turning maneuvers, amount of time spent surfing, and a lower skill level.[9,12] For example, the greater width of a longboard leads to increased shoulder abduction while paddling, which can lead to increased stress on soft tissues at and distal to the shoulder.[9]

The most common gradual-onset surf-related non-musculoskeletal injury is exostosis.[8] Exostosis, also known as surfer's ear, is caused by bony outgrowths from the temporal bone and is more common in cold water surfers.[13] Individuals will experience water trapped in the ear, inflammation of the ear canal, pain in the ear, and impaired hearing.[13] This monograph will focus on musculoskeletal injuries, but it is important to be aware of this condition if a patient has associated symptoms involving the inner ear. Referral to an otolaryngologist is recommended if a patient has signs of exostosis because this can lead to permanent disability.

Traumatic Mechanism

Only 39% of surfers who experience a traumatic injury seek medical treatment at an emergency department or visit their general practitioner.[14] Hay et al[15] determined that 10% of individuals with surfing-related injuries who arrived at the emergency department had severe enough injuries to be admitted.[15] Imaging was recommended for 40% of acute musculoskeletal surf injuries.[11,16] Of those, about 72% were found to have significant tissue injury, with up to 42% requiring surgery.[17,18] The most common body locations for traumatic musculoskeletal injuries, in descending order, are the head and neck, lower extremity, upper extremity, and trunk and back.[7,19] When looking at competitive surfers only, the most common injury sites are the lower extremities, followed by the upper extremities.[11]

The most common traumatic injuries in surfing are actually to the integumentary system by way of skin lacerations, but assessment and treatment of these will not be covered in this monograph.[7,14,19] Fractures are the next most common traumatic injuries and account for 57% of hospital admissions.[7,15] Surfing-related fractures primarily involve the skull, cervical spine, and lower extremities, specifically the ankle, foot, and toes.[7,15] When considering body region-specific injuries, the most commonly injured tissues at the knee are the medial collateral ligament (MCL), menisci, articular cartilage, and anterior cruciate ligament (ACL).[5,11,17] Although most lower extremity injuries occur in the back leg, 62% of MCL injuries occur in the front leg, the most common knee injury in surfers.[10,11] Low and high

ankle sprains comprise the majority (72%) of ankle pathologies, followed by ankle fracture and anterolateral impingement.[11] Rotator cuff tears, labral tears, and dislocations are the most common traumatic pathologies of the shoulder, with a high likelihood of a combination of these pathologies occurring in a single event.[5,11,17] It is essential to be able to differentiate, diagnose, and determine the severity of these injuries to decide the appropriate plan of care.

Typical mechanisms of traumatic surf-related injuries are being hit by a surfboard, impact at the seafloor, striking the water surface, and physical contact with marine wildlife.[5,7,19] Consequently, another injury that needs to be strongly considered when evaluating a patient is a mild traumatic brain injury (TBI) or concussion. Mild TBIs occur in 2.3% to 6.6% of all injuries and 16.1% of head injuries.[14,19,20] Mild-TBIs will be addressed in this monograph, but we recommend a further review of the literature regarding evaluation and treatment.

Risk factors for traumatic tissue injuries consist of performing aerial maneuvers, riding inside a tubular-shaped wave, surfing in crowded waters, riding large waves, surfing in shallow waters, riding waves that break close to the beach, and the presence of rip currents, which are strong flows of surface water away from shore.[5,7,10,14,16,21] Ulkestead and Drogset[14] found that injury risk more than doubled when surfing waves are more than 1 meter high. Individuals who ride shortboards are at greater risk of a traumatic injury.[5,7] Also, the use of alcohol or drugs while surfing can increase the risk of injury.[21]

Finally, the higher the surfer's skill level, the greater the risk for traumatic injury because the individual will likely spend more time in the water, tend to ride bigger and faster waves, and attempt maneuvers that challenge the demands of their bodies. A surfer's skill level can be differentiated into beginner, intermediate, and advanced, with competitive and aerialist surfers falling into the advanced level. Hutt et al[22] described the 3 skill levels. Beginning surfers may or may not be able to ride laterally on a wave but will generally surf straight to shore. They are starting to develop the skill to "pump" the surfboard on the wave to generate more speed. Intermediate surfers can execute standard maneuvers such as a bottom turn, top turn, or cutback. Advanced surfers can position their bodies on their surfboards in almost any part of the wave and can execute more dynamic movements such as the floater, tube riding, and aerials. Refer to the **Appendix** for a description of the terms.

INDICATIONS FOR EXTERNAL REFERRAL

This section will cover the most common traumatic and gradual-onset tissue injuries that may require a follow-up with an orthopedic surgeon, neurosurgeon, or a visit to the emergency room. Because direct access to physical therapy has been adopted in most states, patients may come to a physical therapist first with acute or chronic surf-related injuries. We will present indications for when to recommend an external referral before treatment or refer and treat.

Cervical Spine

Two serious injuries would require urgent referral to a specialist when evaluating a patient with cervical trauma: cervical fracture and upper cervical instability (UCI). These injuries may lead to permanent dysfunction and disability if not addressed appropriately.

Red flags from the history intake indicative of cervical fracture are progressive neurological symptoms, the 5 Ds (diplopia, dizziness, drop attacks, dysarthria, dysphagia), nausea, numbness, gait disturbances, and disequilibrium. A traumatic event would be another red flag with further concern if the surfer has a history of osteoporosis or prolonged steroid use.[23] Jackson et al[24] recommend cervical spinal radiographic imaging if there is polytrauma or head trauma. The Canadian Cervical Spine Rule (CCR) is a clinical prediction tool used to help decide if imaging is appropriate for individuals with trauma, typically from falls or car collisions. When using the CCR, the clinician needs to determine the severity level of a traumatic event from surfing. The CCR has shown high sensitivity for ruling out possible cervical fractures, although it has not been explicitly evaluated for surfing-related trauma.[25–28] **Figure 1** shows the algorithm for making a clinical decision related to trauma. It is recommended to complete other objective testing beyond relying on the red flags and the CCR alone. Assessment of cranial nerves and peripheral neurologic clinical tests for motor, sensory, and reflex functions should further help gauge the injury's severity.[23,24]

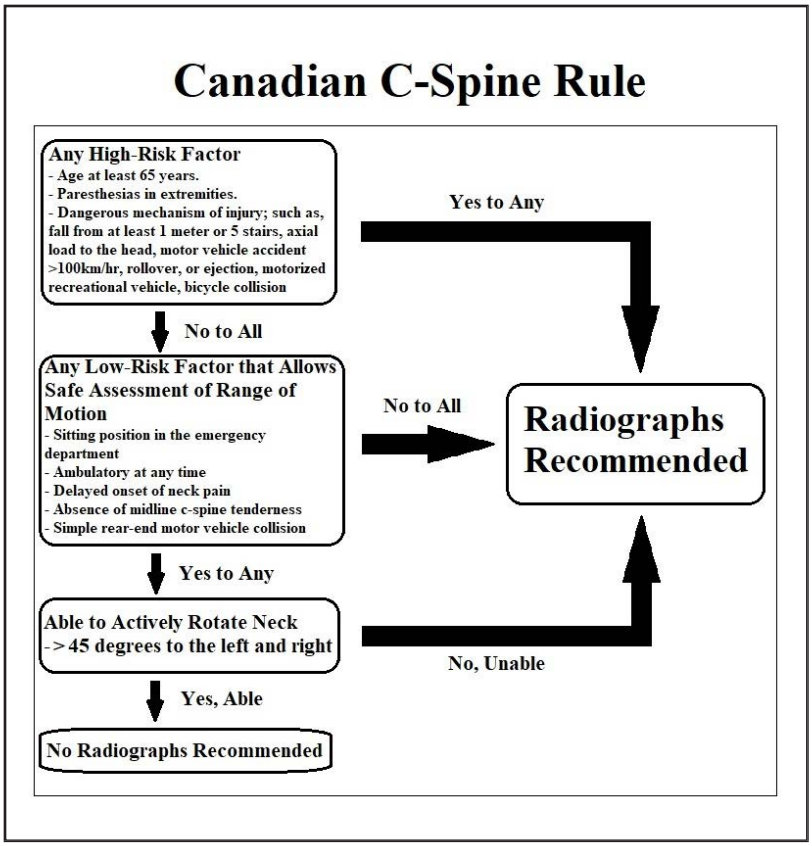
The clinician also should consider the possibility of upper cervical ligamentous injury if the surfer experiences a traumatic injury to the head and neck. Hutting et al[29] completed a systematic review of the diagnostic accuracy of 7 upper cervical spine stability tests. They found high specificities for 7 tests: Sharp-Purser test, alar ligament test, transverse ligament test, tectorial membrane test, atlantoaxial membrane test, clunk test, and Palate sign. But the sensitivities for those tests were low. Therefore, while a positive test suggests the presence of a significant injury, a negative examination does not entirely rule out the potential for injury.

Lumbar Spine

Three serious lumbar spine pathologies are essential to consider with a lumbar spine injury: lumbar fracture, disc herniation with a compromised nerve root, and cauda equina syndrome. The prevalence of spinal fractures in individuals with low back pain admitted to the emergency department is 7.2%.[30] Red flags for spinal fractures are traumatic event, immediate spinal pain post injury that presents as focal tenderness at the midline of the spine, advanced age (>50 years old with increased likelihood when >70), female sex, history of prolonged corticosteroid use, osteoporosis, and osteoarthritis.[30,31]

After sustaining a fracture, the patient may present with abnormal objective findings such as a significant change in

Figure 1. Decision Flowsheet for the Canadian C-Spine Rule[28]



height or spinal shape during postural assessment and buckling of the legs due to weakness during gait assessment.[30] Also, bruising, skin abrasions, or pain at the site of trauma may be observed. The patient may present with positive neurological signs (strength, sensory, or reflex deficits) or a positive percussion test.[31]

Lumbar disc herniation with nerve root involvement should also be considered in a surfing injury affecting the spine. Excessive load to the lumbar disk from impact can lead to a compromised annulus fibrosus and result in the protrusion, extrusion, or sequestration of the nucleus pulposus. The presence of motor weakness, impaired or absent sensory function, and diminished reflexes carries a high specificity for lumbar disc herniation with nerve root involvement.[32] Also, a positive cross straight leg raise test increases the suspicion of a disc herniation with nerve involvement. In contrast, a straight leg raise test is a good screening test for radicular conditions.[33] The likelihood of a herniated disk will increase with the extent of the neurological deficits. In summary, neurological deficits that affect the surfer's function or new onset of neurological signs during treatment would indicate the need for an external referral.

Cauda equina syndrome is a compression of neural structures, possibly from disc herniation, spinal stenosis, or lumbar fracture.[30,34] The patient will present with similar findings, such as a disc herniation with nerve root involvement and other signs and symptoms of unilateral or bilateral radicular pain, bowel or bladder function changes, saddle sensory anesthesia, and sexual dysfunction.[30,31,34] Cauda equina syndrome's prevalence is low, with 0.1% to 1.9% of individuals presenting with lumbar pain in the emergency department, but it should still be considered when evaluating the patient.[35]

Shoulder

The shoulder is commonly injured in surfing. Undetected severe shoulder injuries can lead to chronic pain, functional limitations, and decreased quality of life. Prolonged tissue injury can also lead to poor surgical outcomes if not addressed promptly.

Glenohumeral joint (GHJ) instability makes up about 48% of shoulder injuries in surfers.[11] Instability can occur in the anterior, posterior, or inferior direction or be multi-directional. Van Kampen et al[36] assessed shoulder instability tests. They concluded that a positive release test combined with younger age, previous history of shoulder dislocations, and sudden onset of complaints have high predictive value. Hawkins and McCormack[37] and Staker et al[38] described similar grading systems for instability severity from grade 1 being the least severe to grade 3 being the most. Combining the methods provides a more comprehensive measure. Grade 3, the most severe, is described as having a >2cm translation of the humeral head without spontaneous reduction. Referral out would be necessary for a patient with these findings as the surfer could continue to have repeated dislocations due to the dynamic nature of GHJ motion while paddling. Sixty percent of individuals with shoulder dislocations have concomitant rotator cuff tears, labral tears, and fractures, reinforcing the need for an external referral.[39]

The second most common shoulder injury for a surfer is at the rotator cuff.[11] Many special tests in the literature help determine the presence of a rotator cuff tear. The best tests for identifying tears >2cm that may benefit from early surgical intervention are the drop arm test and the full can test for identifying supraspinatus tears; the external rotation lag test at 0° abduction and Hornblower's sign for infraspinatus tears; the external rotation lag at 40° abduction for teres minor tears;

and finally, the belly press and bear hug tests for subscapularis tears.[35,40]

A labral tear, specifically a superior labrum anterior to posterior (SLAP) tear, is the shoulder's third most common injury.[11] Not all labral tears need urgent referral to an orthopedic surgeon, and conservative management of SLAP tears tends to be the initial treatment approach.[41] Clark et al[42] assessed 5 clinical tests: the Biceps Load I, Biceps Load II, Speed's test, O'Brien's test, and Passive Compression test. They found good diagnostic accuracy for these tests individually, with the Biceps Load I and II showing the best results. They concluded that any combination of 3 positive results out of the 5 tests had better diagnostic accuracy than magnetic resonance imaging (MRI) or magnetic resonance arthrogram (MRA). A labral tear that does not improve with conservative treatment or limits daily activities would benefit from further assessment by an orthopedic surgeon.

It is essential to consider the high likelihood of multiple tissue pathologies in the shoulder when encountering a significant traumatic or gradual-onset shoulder injury.[11] The more complex the shoulder injury presents, the greater the need for the patient to be under the care of an orthopedist.

Hip

Femoral-acetabular impingement is the most common hip pathology in surfers.[11] This could be due to the sitting position on the board with the surfer's hips maintained in flexion and abduction. There are inconsistent indications for when an individual would benefit from surgical intervention.[43,44] If the patient continues to have disabling symptoms after a trial of conservative management and has radiographic findings of structural abnormalities, positive impingement tests, and limited hip internal rotation, surgery may be indicated.[43,44]

Knee

The knee is a common location of injury, especially in the competitive surfer. The most frequently injured structures are the MCL, ACL, menisci, and bones: patella, femur, tibia, or fibula.[11]

After a trauma, the potential for having a fracture at the tibia, femur, or patella can be assessed using the Ottawa Knee Rule. The Ottawa Knee Rule has a sensitivity of 99% to 100% and a specificity of 23% to 49%.[45,46] The rule has a high negative predictive value that would indicate a very low probability that the patient has a knee fracture if they do not meet any of the criteria for the rule. Imaging is recommended if the patient presents with at least one of the criteria of the Ottawa Knee Rule. **Table 1** shows the indications for recommending radiographs based on the Ottawa Knee Rule.

Two primary ligaments are injured at the knee while surfing: the ACL and MCL. The ACL is a key structure that controls rotational forces and anterior translation of the tibia in relation to the femur.[47] The Lachman test has the highest diagnostic accuracy compared to other tests.[48–50] Benjaminse et al[48] recommend using the Lachman test for acute injuries, but if a chronic ACL tear is suspected, then the Anterior Drawer test is also a good option. Findings show that a delay in surgical intervention >6 months with an associated medial meniscus injury increased the odds of having pre-reconstruction knee laxity, and >12 months delay increased the odds of acquiring concomitant cartilage and medial meniscus injury.[51]

Table 1. Ottawa Knee Rule Indications for Radiographs[45,46]

Ottawa Knee Rule Criteria
Imaging is recommended if any of the below criteria are met. • Age >55 years old • Tenderness at either the: o Fibular head o Isolated to the patella • Inability to flex the knee >90° • Inability to bear weight 4 steps immediately or in the emergency department

The most commonly injured structure in a surfer's knee is the MCL.[11] The MCL's primary purpose is to resist valgus stresses, but it also controls rotational forces.[47,52,53] The patient will present with local pain, swelling, and tenderness to palpation at the location of the MCL or its attachment sites, a sensation of a pop or tear during the initial onset, yet would still have the ability to ambulate after the injury without significant instability.[54,55] Swelling and bruising will occur immediately if a severe tear is suspected.

Most MCL injuries heal without the need for surgery. But, surgical intervention is warranted if there is suspected intraarticular entrapment of the ligament, a large bony avulsion at either insertion site, associated tibial plateau fracture, or when anteromedial rotatory instability is present on physical examination.[54] Also, individuals who present with structurally more genu valgus may place more stress on the healing MCL, leading to a poorer prognosis.[54]

Other commonly injured structures at the knee are the menisci. The medial meniscus has attachments to the MCL and the ACL via the intermeniscal ligament. The lateral meniscus attaches to the posterior cruciate ligament (PCL).[52,56] The inner portion of the meniscus is mostly avascular, which does not allow for proper healing. But the peripheral 10% to 25% of the lateral meniscus and 10% to 30% of the medial meniscus are vascularized, which is essential for healing post-surgical repair.[56]

No single test is sufficient in detecting a meniscal tear.[49,50,57] Combining tests such as the McMurray and Apley shows similar diagnostic accuracy to an MRI and is recommended to rule in or out a meniscal injury.[57] If the patient presents with 3 out of 5 signs and symptoms (history of catching or locking, pain with forced knee hyperextension, pain with maximum passive knee flexion, joint line tenderness, or a positive McMurray test), the sensitivity is 30.8%, and specificity is 90.2%.[58] A suspected meniscal injury that leads to instability during weight-bearing activities or locking during range of motion (ROM) will need to be evaluated further.

It is common for multiple knee structures to be simultaneously injured after a contact or non-contact mechanism of injury. One study reported that 67% of individuals scheduled for surgery for an isolated ACL injury also had evidence of MCL complex injuries.[52] An MCL tear can also be associated with a medial meniscal injury due to their combined attachment.[52] With the classic femoral adduction and internal rotation injury pattern for non-contact ACL injuries, an associated lateral meniscus injury can occur due to lateral compression from the valgus force. Surfers are susceptible to complex tissue injuries at the knee due to the dynamic movement on the board or the multi-directional forces at the knee in turbulent water. Imaging and surgical intervention may be the most appropriate option for the patient if a multi-structure injury is suspected.

Ankle and Foot

The ankle and foot are common areas for injury, and the prevalence of recurrent or chronic symptoms is high. The ankle and foot are the initial areas of the body that transmit forces from the board to the surfer and from the surfer back to the board. The dynamic nature of the ankle and foot and the opposing forces acting on it make it susceptible to injury. We will review the most common ankle and foot injuries needing immediate referral and signs suggesting when conservative treatment may not be successful.

Consideration for fracture is essential when evaluating a patient with a surf-related injury. Screening for a fracture at the foot and ankle can be completed using the Ottawa Ankle and Foot Rule.[59,60] The description of the Ottawa Ankle and Foot Rule can be seen in **Table 2**. Immediate imaging may also be recommended if the patient's symptoms are indicative of a Lisfranc fracture or fractures of the toes, metatarsophalangeal joint injury, or if the patient has neurovascular deficits.[59]

Ankle sprains are another set of injuries the clinician should consider when deciding the patient's appropriateness for rehabilitation. Ankle sprains can easily occur in surfers because of the ROM required when riding on the board and the demand needed to control a moving board. Most ankle sprains can be managed by non-surgical treatment, but some severe injuries may warrant a referral. The patient's location of pain, presence of hematoma or swelling, prior level of function versus current status, and objective findings should be considered when deciding the most appropriate care plan.

Table 2. Ottawa Ankle and Foot Rule Indication for Radiographs[60]

Ottawa Ankle and Foot Rule Criteria
Imaging is recommended if any of the below criteria are met. • Inability to bear weight 4 steps immediately after injury or in the emergency department • Tenderness at either: o The distal 6 cm of the posterior half of the tibia or tip of the medial malleolus o Along the distal 6 cm of the posterior half of the fibula or the tip of the lateral malleolus o The base of the 5th metatarsal bone o The navicular bone

Lateral ankle sprains, medial ankle sprains, and high ankle sprains, or a combination of the three, are possible with surfing injuries. A lateral ankle sprain is most common due to excessive combined plantar flexion and inversion of the talocrural and subtalar joints, leading to injuries to the anterior tibiofibular, the calcaneofibular, or the posterior talofibular ligament.[61] The sensitivity and specificity for the reverse anterolateral drawer test were greater than 85%.[62] The talar tilt test can also be used for lateral ankle sprains to assess the calcaneofibular ligament.[61]

Injury to the medial ankle is less common due to the relatively high structural tolerance of the deltoid ligament complex. Injury tends to occur more often in the back leg of a shortboard surfer. The deltoid ligament complex resists external rotation and lateral translation of the talus. A clinical diagnosis is made primarily using the ankle external rotation test and associated pain at the medial ankle.[61] Injury to this ligamentous complex tends to occur in combination with injuries to other ankle ligaments and distal tibial or fibular fractures due to the high forces involved to compromise its integrity.[61]

Low-grade injuries to multiple ligaments may benefit from an assessment by an orthopedic surgeon or sports medicine physician. Also, an orthopedic consult should be considered when a patient has chronic ankle pain (>6 months), persistent ROM limitations, swelling at the anterolateral groove, and a sensation of locking and snapping during dorsiflexion and eversion of the ankle, despite conservative management.[63] Chronic recurrent ankle instability may also warrant an external referral.[59,61]

High ankle sprains, also known as syndesmotic injuries, are injuries to the anterior inferior tibiofibular, posterior inferior