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Acute Lower Extremity Fracture Management in Chronic Spinal Cord Injury

2022 Delphi Consensus Recommendations

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Background: Our objective was to develop a clinical practice guideline (CPG) for the treatment of acute lower extremity fractures in persons with a chronic spinal cord injury (SCI).

Methods: Information from a previous systematic review that addressed lower extremity fracture care in persons with an SCI as well as information from interviews of physical and occupational therapists, searches of the literature, and expert opinion were used to develop this CPG. The Grading of Recommendations, Assessment, Development and Evaluations (GRADE) system was used to determine the quality of evidence and the strength of the recommendations. An overall GRADE quality rating was applied to the evidence.

Conclusions: Individuals with a chronic SCI who sustain an acute lower extremity fracture should be provided with education regarding the risks and benefits of operative and nonoperative management, and shared decision-making for acute fracture management should be used. Nonoperative management historically has been the default preference; however, with the advent of greater patient independence, improved surgical techniques, and advanced therapeutics and rehabilitation, increased use of surgical management should be considered. Physical therapists, kinesiotherapists, and/or occupational therapists should assess equipment needs, skills training, and caregiver assistance due to changes in mobility resulting from a lower extremity fracture. Therapists should be involved in fracture management as soon as possible following fracture identification. Pressure injuries, compartment syndrome, heterotopic ossification, nonunion, malunion, thromboembolism, pain, and autonomic dysreflexia are fracture-related complications that clinicians caring for patients who have an SCI and a lower extremity fracture may encounter. Strategies for their treatment are discussed. The underlying goal is to return the patient as closely as possible to their pre-fracture functional level with operative or nonoperative management.

Estimates of the number of Americans living with spinal cord injury (SCI) range from 300,000 to 1.2 million[1,2]. Lower extremity fractures are common occurrences for persons with a chronic SCI, with 1 report suggesting that 25% to 46% of these individuals will sustain a lower extremity fracture during their lifetime[3]. Other investigators have reported that more than half of persons with an SCI will suffer a low-impact or osteoporotic fracture at some point following the injury[4]. The majority of fractures occur in the lower extremity[5,6]. Fracture rates are substantially higher in the SCI population compared with the able-bodied population[7]. These fractures are associated with both high morbidity[8] and excess mortality[9].

Traditionally, these lower extremity fractures have been treated nonoperatively[10]. However, with improvements in surgical techniques and implants[11,12], and recognition of complications related to conservative therapies[10], operative interventions are more frequent[10,13,14]. In 1 series in which the majority of fractures were treated without surgery, 53% of patients sustained at least 1 fracture-related complication (e.g., nonunion/delayed union and/or pressure injuries). Pain, autonomic dysreflexia, heterotopic ossification at the fracture site, and increased risk of hospitalization also have been reported as fracture-related complications in this population[15]. Other fracture sequelae may include infection[16], functional impairment[17], and limb amputation[18,19]. However, to

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date, there is no consensus on the optimal treatment of lower extremity fracture complications in patients with an SCI. To address this gap, with oversight from the Orthopaedic Trauma Association (OTA) and with funding provided by VA Health Services Research & Development (VA HSR&D), an expert panel was convened to develop a clinical practice guideline (CPG) for lower extremity fracture management in persons with a chronic SCI. This CPG includes (1) the specific recommendation; (2) the GRADE (Grading of Recommendations, Assessment, Development and Evaluations) rating, including the letter and number ranking the quality of the evidence and the strength of the recommendation; and (3) conclusions. The Appendix includes (1) a literature review that guided the recommendations, (2) a supplementary table that indicates the members of the expert panel with their areas of expertise, and (3) a supplementary table with information on which members of this expert panel were responsible for each section of the literature review.

Materials and Methods

Delphi techniques guided the development of this CPG. The initial activity included developing a set of key questions regarding lower extremity fracture management. Questions were solicited from national and international leaders in research and clinical care in SCI. The Patient, Intervention, Comparison, Outcome (PICO)-formatted questions relating to the acute management of lower extremity fractures and the background (clinical context) that formed the basis for these recommendations are reported in the main manuscript.

The CPG consists of 3 sections: acute fracture treatment, the role of physical therapy, and the management of fracture-related complications. The key questions for the acute treatment section were: (1) Is the preferred primary (first) management operative or nonoperative? (2) What are the optimal nonoperative treatments? and (3) What are the optimal operative treatments? The key question for the rehabilitation section was: What is the role of physical therapy in post-fracture rehabilitation? The key question for the post-fracture complications section was: What are important considerations in the prevention and management of post-fracture complications and fracture treatment failures?

These questions formed the basis of a literature search, the findings of which were published as a systematic review[20]. A multidisciplinary expert panel consisting of orthopaedic surgeons, physiatrists, physical therapists, health service and clinical researchers, an endocrinologist, a rheumatologist, and a hematologist was convened. Details on the expert panel and specific areas addressed by each panel member are included in the Appendix. Prior to the first in-person meeting, all conflicts of interest (COIs) were identified. Updates to these COIs occurred prior to the second meeting and again prior to publication. The guidelines were informed in part by the AAOS Clinical Practice Guidelines and Systematic Review methodology[21]. Information from the systematic review[20], semi-structured interviews of physical and occupational therapists[22], additional manual searches of the literature performed by members of the expert panel to inform particular areas of knowledge gaps, and expert opinion by members of the task force formed the basis for the recommendations. Panel members consulted with content experts when needed. The GRADE system was used to determine the quality of evidence and the strength of the recommendations[23-25]. An overall GRADE quality rating was applied to the evidence across outcomes by taking the lowest quality of evidence from all of the outcomes[26]. A priori, it was decided that the maximum grade that could be given for the quality of evidence was low if data were obtained only from the able-bodied population, with no reports available for individuals with an SCI. Table I indicates the original GRADE scoring system[27], and how this original scale was applied to these guidelines, with use of letters (A to D) to rank the quality of the evidence and numbers (1 to 2) to rank the strength of these recommendations. For example, Grade 1C indicates a low quality of evidence and strong recommendations either for or against intervention, Grade 1D indicates a very low quality of evidence and strong recommendations either for or against an intervention, and Grade 2D indicates a very low quality of evidence and weak recommendations either for or against an intervention.

Individual recommendations initially were developed by the expert members of each section. These recommendations were then voted on independently by all members of the expert panel, with comments allowed for each recommendation using a survey format (Qualtrics). Minor formatting changes were suggested for 4 of the recommendations and were incorporated into the final recommendations. There was disagreement by 1 panel member on the recommendation concerning internal fixation for treatment of a femoral neck fracture (Recommendation 1.5); specifically, that there was not sufficient information to inform specific operative treatment of femoral neck fractures in persons with an SCI. An advisory panel consisting of 3 outside experts in the care of persons with an SCI also independently reviewed the guidelines. This outside advisory panel included 1 endocrinologist and 2 orthopaedic surgeons. Suggestions from this expert outside advisory panel resulted in the inclusion of information on exoskeleton use and foot fractures and clinical

TABLE I Quality of Evidence and Strength of Recommendation Used

	Letter or Number
Quality of evidence	
High	A
Moderate	B
Low	C
Very low	D
Strength of recommendation	
Strong for an intervention	1
Weak for an intervention	2
Weak against an intervention	2
Strong against an intervention	1

considerations regarding these topics. Expert panel members were then asked to review a final draft of the guidelines that included the new statements that had been formulated following the first round of responses, including the formatting changes and the recommendations regarding information on exoskeleton use and foot fractures. All members of the expert panel approved the final guidelines. Members of the OTA Evidence-Based Quality Value and Safety (EBQVS) Committee also reviewed and unanimously endorsed these guidelines. In addition, the OTA Board of Directors approved these guidelines.

This CPG, while based on what the panel considered to be the best available evidence, consisted largely of expert opinion, so future updates may be necessary. Moreover, many of the guidelines related to surgical procedures were informed by the literature and practice related to the able-bodied population with lower extremity long-bone fractures because of a dearth of high-quality evidence in this area specific to persons with an SCI. It is recommended that future research studies address the risks and benefits of operative versus nonoperative treatment of acute lower extremity fractures and optimal operative and nonoperative treatment strategies for these fractures in persons with an SCI. It is recognized that, given the relatively few patients with an SCI, such studies would need to be multi-institutional and most likely international.

Moreover, the critical importance of prevention of these fractures is recognized, and, for a full discussion of the role of osteoporosis medications in the prevention of fractures in persons with an SCI, the reader is referred to the Paralyzed Veterans of America (PVA) Consortium for Spinal Cord Medicine Clinical Practice Guidelines: Bone Health and Osteoporosis Management in Persons with Spinal Cord Injury[28].

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Summary of Recommendations

Section I: Acute Fracture Treatment

1.1 Recommendation

We recommend that patients with an SCI who sustain a lower extremity fracture be provided with education regarding the risks and benefits of operative and nonoperative management. We recommend that shared decision-making between patient and provider be conducted when making a decision regarding definitive fracture management.

Grade: 1D

1.2 Recommendation

We recommend that consultation with an orthopaedic surgeon and engagement of appropriate multidisciplinary teams, as clinically indicated, should be done as soon as possible when a lower extremity fracture is identified.

Grade: 1D

1.3 Recommendation

We recommend operative management for open lower extremity fractures. These fractures should be treated with irrigation and debridement, with appropriate antibiotic coverage and wound closure as soon as possible to reduce complications related to infection, and surgical stabilization should be considered. We recommend operative management for any lower extremity fracture that the orthopaedic surgeon determines will not reliably heal in a position that will restore the patient to their pre-fracture functional status.

Grade: 1C

Clinical Considerations: Operative management of these fractures with appropriate antibiotic coverage should be performed as soon as feasible when the patient is medically stable. Treatments should take into account the severity of the open fracture and should follow EBQVS Committee recommendations.

1.4 Recommendation

We recommend that factors to consider in decision-making relative to fracture treatment are the risks and benefits of operative versus nonoperative approaches for the individual patient, the premorbid level of function, patient preferences, and the impact of fracture management strategies on vocation, avocation, independence, and the use of current and future mobility technologies.

Grade: 1C

1.5 Recommendation

If operative management is chosen, we recommend the following, in conjunction with physical therapy.

- *Hip*
  - Femoral neck (intracapsular)
    - Nondisplaced: Internal fixation.
    - Displaced: Arthroplasty or resection. Resection can be considered but raises risk of proximal femoral migration and subsequent pressure injury and sitting imbalance.
  - Intertrochanteric: Internal fixation with intramedullary nail (IMN) fixation.
  - Subtrochanteric: Internal fixation with a long IMN, with fixation into the femoral head.
- *Femur*
  - Proximal and mid-shaft: Internal fixation spanning the entire femur, with fixation into the femoral head. Consideration for supplemental fixation as needed.
  - Distal: Internal fixation (plate or IMN, or plate and IMN in combination).
- *Tibia/Fibula*
  - Proximal/mid-shaft: Internal fixation or external fixation (consideration for a circular fixator).

- Distal: Internal fixation or external fixation (consideration for a circular fixator).
- *Ankle*
  - Internal fixation or external fixation (consideration for a circular fixator).
- *Foot*
  - Internal fixation, external fixation (consideration for a circular fixator), or percutaneous fixation.

Grade: 1C

Clinical Considerations: The advent of Exoskeleton Assisted Walking (EAW) has led to an appreciation that persons with an SCI have a high predisposition for foot and ankle fractures. The bone mineral density (BMD) of the calcaneus/foot likely will be markedly reduced, and the patient should avoid early return to weight-bearing activities after healing of the fracture because of the high risk of refracture with upright activities.

1.6 Recommendation

If nonoperative management is chosen, we recommend the following.

- Utilization of well-padded immobilization devices (or well-padded support of the fracture site when immobilization is not feasible), with attention to pressure relief over osseous prominences.
- Immobilization devices should allow for easy and frequent skin inspection and should maintain neutral rotation and alignment.

Grade: 1D

1.7 Recommendation

If nonoperative management is chosen, we recommend the following, in conjunction with physical therapy.

- *Hip*
  - A well-padded positioning support with attention to neutral rotation and alignment. Range of motion may be as tolerated if the hip fracture is relatively nondisplaced and stable, with monitoring for worsening fracture characteristics (e.g., displacement) and rotation/alignment. Range-of-motion exercises are not recommended for unstable intertrochanteric or subtrochanteric fractures.
- *Femur*
  - Proximal/mid-shaft: A well-padded immobilization device.
  - Distal: A well-padded immobilization device with transition to a hinged brace when there is clinical/radiographic evidence of stability.
- *Tibia/Fibula*
  - Proximal/mid-shaft: A long-leg well-padded immobilization device with transition to a shorter padded immobilization device when there is clinical/radiographic evidence of stability.
  - Distal: A well-padded immobilization device.
- *Ankle*
  - A well-padded positioning support device.
- *Foot*
  - A well-padded positioning support device.

Grade: 1D

Section II: Role of Physical Therapy: Functional, Positional, and Mobility Considerations

2.1 Recommendation

We recommend that therapists (physical therapists [PTs], kinesiotherapists [KTs], and occupational therapists [OTs]) should be involved in fracture rehabilitation as soon as possible to assess equipment needs, skills training, and caregiver assistance due to changes in mobility.

Grade: 1D

Clinical Considerations: When fractures are managed nonoperatively, the involvement of/consultation with PTs prior to the selection of braces should be considered. During the acute management phase, the focus should be on access to the environment and return to the prior level of their living situation. After acute management, return to the full prior level of participation in activities, including leisure and recreational activities, should be a priority. If the patient is unable to return to their prior living situation after the fracture, social workers should be involved to assist.

2.2 Recommendation

We recommend that orthopaedic surgeons engage in early and ongoing communication with therapists regarding range of motion, weight-bearing, and transfer restrictions and that these instructions should be updated as fracture-healing progresses.

Grade: 1D

2.3 Recommendation

We recommend that someone who is knowledgeable in wheelchair seating (e.g., physical medicine and rehabilitation/physiatrist, physical therapist, or a wheelchair specialist if available) should be involved in post-fracture care for wheelchair users to assess needs related to support of the fractured limb, alignment abnormalities, limb-length discrepancies, and/or seating posture during and following fracture management.

Grade: 1D

Section III: Post-Fracture Complications

3.1 Recommendation

We suggest surgical intervention for the treatment of (1) a nonunion or malunion associated with residual deformity that impairs functional ability or (2) a fracture that has converted to an open fracture following the failure of nonoperative treatment.

Surgical treatment should be considered for a National Pressure Ulcer Advisory Panel (NPUAP) Stage-3 or 4 pressure injury that has failed to heal with conservative therapy.

Grade: 2D

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Clinical Considerations: Orthopaedic options following the failure of nonoperative treatment of a lower extremity long-bone fracture depend on the clinical situation and may include excision or resection of bone or soft tissue, malunion or nonunion correction, fracture fixation, wound debridement and closure, soft-tissue release, or amputation.

3.2 Recommendation
We suggest that individuals with an SCI and an acute lower extremity fracture should be monitored for the development of acute compartment syndrome.
Grade: 2D

Clinical Considerations: Monitoring of creatine phosphokinase (CPK) levels and renal function may be necessary to assist in determining the rare need for fasciotomy or debridement.

3.3 Recommendation
We suggest that nonsteroidal anti-inflammatory drugs (NSAIDs) may be considered to prevent progression of heterotopic ossification (HO) post-fracture.
Grade: 2D

Clinical Considerations: We suggest that excision of HO should only be considered in persons in whom the HO location and configuration place the patient at risk for NPUAP Stage-3 or 4 pressure injury or interfere with necessary range of motion for function, after confirmation that no vascular structures are encased within the HO. Second and third-generation bisphosphonates should not be used to treat HO.

3.4 Recommendation
We suggest that clinicians consider using parathyroid analogues such as teriparatide in addition to operative or nonoperative treatment for fractures that are at risk for nonunion (e.g., distal femoral fractures, unstable tibial fractures) during the acute fracture-healing period.
Grade: 2D

3.5 Recommendation
We suggest that if nonunion affects functional activity or creates pressure concerns, providers should consider referral to a metabolic bone specialist for use of teriparatide and/or surgical intervention to attain union. If a malunion affects functional activity or creates pressure concerns, providers should consider surgical interventions.
Grade: 2D

3.6a Recommendation
We recommend that clinicians routinely assess the risk of venous thromboembolism (VTE) following an acute lower extremity fracture.
Grade: 1C

3.6b Recommendation
We recommend that, following an acute lower extremity fracture, clinicians routinely provide anticoagulant thromboprophylaxis with a low-molecular-weight heparin (LMWH) or a direct oral anticoagulant (DOAC) (if there are no contraindications) or obtain the advice of a health professional with expertise in the area of thromboprophylaxis, such as an SCI rehabilitation physician, hematologist, thrombosis specialist, or internist.
Grade: 1D

3.6c Recommendation
We recommend that thromboprophylaxis start as soon after the fracture as is feasible.
Grade: 1C

3.6d Recommendation
We suggest that, for persons who are admitted to the hospital, thromboprophylaxis should continue at least until discharge from acute care and rehabilitation, with consideration of a total duration of at least 2 to 4 weeks.
Grade: 2D

3.6e Recommendation
We suggest that, for persons with an SCI who are not admitted to the hospital, thromboprophylaxis should continue for a total duration of at least 2 to 4 weeks.
Grade: 2D

3.6f Recommendation
We recommend that clinicians proactively consider the risk of increased leg edema and skin injury and utilize multilayered compression wraps to help mitigate these adverse events in those who are at risk.
Grade: 1D

3.7a Recommendation
We recommend that clinicians use the Orthopaedic Trauma Association (OTA) post-fracture pain management guidelines and the CanPain SCI guidelines[29] to inform decision-making regarding therapy selection for post-fracture pain and neuropathic pain exacerbation, respectively.
Grade: 1A

3.7b Recommendation
We suggest that clinicians monitor persons who have an SCI and a recent lower extremity fracture for signs and symptoms of inadequate pain management triggering autonomic dysreflexia (AD) in the first 48 to 72 hours post-fracture[28].
Grade: 2D

3.7c Recommendation
We suggest that surgeons consult a pain specialist or the treating physiatrist if the individual with an SCI, prior to the fracture, was on >100 morphine milligram equivalents (MME)/day of extended-release opioids or >3 concurrent medications for the management of neuropathic pain.
Grade: 2D

3.7d Recommendation

We recommend a referral for psychological support following a lower extremity fracture in patients with an SCI and a propensity for depression, anxiety, or posttraumatic stress or poor coping strategies (catastrophic thinking and low self-efficacy)[30].

Grade: 1C

3.7e Recommendation

We recommend that, when selecting post-fracture pain management therapy, clinicians consider the individual's risk of pain management misuse and monitor for substance use behaviors and psychological indicators during therapy.

Grade: 1C

3.7f Recommendation

We recommend that clinicians pay as much attention to the initiation of analgesic medications as to the tapering and discontinuation of these medications during or after fracture-healing.

Grade: 1C

Conclusions

The role of surgical treatment of fractures in patients with an SCI continues to evolve with our understanding of the role of skeletal stability in improved post-injury mobilization. Surgical treatment precludes external immobilization and allows patients to quickly return to their pre-fracture state. Surgical treatment decreases the rate of pressure injuries and joint stiffness associated with nonoperative treatment while improving wheelchair sitting balance[10,13,31]. Concerns about the rate of surgical complications have merit[32], but, as surgical techniques and implant technology improve, the safe surgical treatment of lower extremity fractures in patients with an SCI may become more widely adopted.

Challenges associated with operative treatment and the reluctance to operate on patients with an SCI are in part due to atrophic soft tissues and osteopenia[33,34]. Locked plating, intramedullary nailing, and circular external fixation technology have increased surgical options[35,36].

More rigid fixation may allow for early unrestricted range of motion in persons with chronic SCI without increasing overall complication rates. It is possible that improved fracture stability after surgical management may lead to a reduction in nonunion/malunion rates[37] and allow early return to function, but studies in this area are needed.

These specific surgical recommendations for lower extremity fractures in patients with an SCI were informed by evidence from the able-bodied population. However, the application of fracture principles used when treating able-bodied persons with osteoporosis may be considered when surgically treating fractures in patients with an SCI. Load-sharing constructs are preferable for providing biomechanical stability, and augmenting fixation should be considered to prevent early fixation failure. Also, the use of modalities to accelerate/augment fracture-healing should be considered for fractures with a high nonunion risk. The 1 exception to this concept is in cases of foot/ankle fractures. The advent of EAW brought to attention the fact that individuals with an SCI have a predisposition to fractures of the foot and ankle[38]. Fractures of the calcaneus[39] and talus[38] have been reported following EAW. This is at least in part due to the rapid demineralization that occurs with immobilization in these predominantly trabecular bone sites[40,41]. Thus, one should avoid early weight-bearing activities after healing of the fracture because of the high risk of refracture with upright activities.

We are not aware of any study that has compared different surgical procedures for lower extremity fractures in patients with an SCI. Favorable techniques focus on immediate stability and are minimally invasive[10,42,43]. In small case series, these techniques have produced acceptable outcomes when used for the treatment of fractures of the femur and tibia[34,44]. Further comparative studies are needed to confirm these recommended techniques, but the principles of soft-tissue-friendly but biomechanically sound surgical treatment are highlighted by the recommendations in this document.

Patients with an SCI and an acute lower extremity fracture should be provided with education regarding the risks and benefits of operative and nonoperative management. Shared decision-making for fracture management should be used, the same as with all patients[45]. Nonoperative management has historically been the default treatment preference; however, with the advent of greater patient independence, improved surgical techniques, and advanced therapeutics and rehabilitation, the increased use of surgical management should be considered. Surgical treatment can prevent complications (e.g., pressure injuries, nonunions, and malalignment) that can negatively impact independence. Early consultation with physiatrists, physical therapists, and endocrinologists can help to optimize treatment and outcomes. Given the increased risk of fracture nonunion in patients with an SCI, consideration of bone-healing adjuvants may be considered. Prevention of thrombosis and consideration of post-fracture pain control are necessary.

Appendix

eA Supporting material provided by the authors is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJSOA/A445). ■

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