

Calcaneal Achilles Avulsion Fracture: Clinical Practice Guideline

Background

Avulsion fractures of the posterior calcaneal tuberosity are rare injuries; with a prevalence of 1-3% of all calcaneal fractures. This type of extra-articular fracture is typically the result of twisting forces in the hindfoot. Conversely, intra-articular fractures are typically the result of axial loading from a fall from height or a motor vehicle collision. Due to the low incidence, little is known about this specific injury. There is lack of knowledge on the pattern of injury, anatomic variables, and specific prognostic factors. This type of injury is seen most frequently in elderly and diabetic populations as a result of low-energy trauma. The avulsion fracture is caused by concentric contraction of the gastrocnemius-soleus muscle complex. Displacement can compromise skin integrity over the posterior aspect of heel requiring early recognition and management. Surgical management requires reduction and stable fixation followed by rehabilitation. Non-operative management is possible in certain cases depending on skin compromise and degree of fracture displacement. This type of injury may also be seen in a younger population as a result of high-energy trauma.

Fractures of the calcaneal tuberosity can be further sub-classified into type I-IV:

- Type I: simple extra-articular avulsion fracture
- Type II: beak style fracture with an oblique fracture line running posterior
- Type III: infrabursal avulsed fracture by superficial fibers from the middle third of the posterior tuberosity
- Type IV: beak style fracture with small triangular fragment separated by deep fibers only from the upper border of the tuberosity

These rehabilitation recommendations are based upon the guidance of content experts and evidence-based practice. Progression through each phase is based on the patient demonstrating readiness by achieving functional criteria rather than the elapsed time from surgery. The time frames identified for each phase of rehabilitation are approximate times for the average patient, NOT concrete guidelines for progression.

Disclaimer

Progression is time and criterion-based, dependent on soft tissue healing, patient demographics and clinician evaluation. If you are working with an Ohio State Sports Medicine patient and questions arise, please contact the author by calling our office at (614) 293-2385.



Summary of Recommendations

Risk Factors for Rupture	<ol style="list-style-type: none"> 1. Age (70 years and older) 2. Female > Male 3. Strength of calcaneal bone/mineral density 4. Intrinsic tightness of gastrocnemius muscle 5. Comorbidity of diabetes
Precautions	<ol style="list-style-type: none"> 1. Surgical <ol style="list-style-type: none"> a. NWB x 6-8 weeks s/p surgical fixation b. Weight bearing is then gradually progressed over the next 6 weeks 2. Conservative Management <ol style="list-style-type: none"> a. Surgical management is gold standard based on current research. This is due to potential development of additional tissue damage from avulsed bone b. Conservative progression dependent on physician guidance 3. No aggressive stretching of Achilles or gastrocnemius-soleus complex before 12 weeks <ol style="list-style-type: none"> a. Do not push for end range and do not stretch into pain 4. Due to nature of injury and possibility of skin breakdown it is imperative to monitor wound healing and presence of decubital ulcer throughout early post-operative phase in all patient populations
Outcome Tools	<p>Collect the Lower Extremity Functional Scale (LEFS) at each visit.</p> <p>Consider collecting one of the following outcome tools. Be consistent with which outcome tool is collected each visit.</p> <ol style="list-style-type: none"> 1. The Foot and Ankle Ability Measure (FAAM) 2. The Achilles Tendon Total Rupture Score (ATRS)
Criteria to Discharge Walking Boot	<ol style="list-style-type: none"> 1. <u>ROM</u>: able to achieve 0deg DF 2. <u>Weight Bearing</u>: Demonstrates pain-free ambulation without antalgic gait 3. <u>Timeframe</u>: <ol style="list-style-type: none"> a. Surgical: Begin progression to weight bearing out of boot starting week 6-8 <ol style="list-style-type: none"> i. Postoperative protocols vary based on the type of fixation used – consult the surgeon for specific guidance b. Conservative: Progression to weight bearing as tolerated (WBAT) after 6-8 weeks of cast immobilization. Cast is utilized in most conservative cases vs walking boot
Criteria to Initiate Running and Jumping	<ol style="list-style-type: none"> 1. <u>ROM</u>: 95% symmetry ROM (DF/PF) compared to uninvolved limb 2. <u>Anthropometrics</u>: 95% symmetry in calf circumference at 10 cm distal to tibial tubercle compared to uninvolved limb 3. <u>Weight Bearing</u>: normalized gait and jogging mechanics 4. <u>Strength</u>: 25 single leg heel raises with heel height within 20% of uninvolved limb 5. <u>Timeframe</u>: Initiate between Weeks 16-20 weeks
Criteria for Return to Sport	<ol style="list-style-type: none"> 1. <u>ROM</u>: 95% symmetry ROM (DF/PF) compared to uninvolved limb 2. <u>Weight Bearing</u>: Normalized gait and jogging mechanics 3. <u>Strength</u>: ≤10% plantarflexor asymmetry at 0deg DF and ≤25% asymmetry at 20deg PF with handheld dynamometer compared to uninvolved limb (Appendix A) 4. <u>Neuromuscular control</u>: 90% symmetry between limbs on Y-balance test with appropriate lower extremity mechanics 5. <u>Functional Hop Testing</u>: 90% symmetry SL hop testing (Appendix B) 6. <u>Physician Clearance</u> 7. <u>Timeframe</u>: Initiate between 6-12 months



RED/YELLOW FLAGS

Red flags are signs/symptoms that require immediate referral for re-evaluation. Yellow flags are signs/symptoms that require modification to plan of care.

Red Flags	<ul style="list-style-type: none"> • Signs of DVT (<i>Refer directly to ED</i>) <ul style="list-style-type: none"> ○ Localized tenderness along the distribution of deep venous system ○ Entire LE swelling ○ Calf swelling >3cm compared to asymptomatic limb ○ Pitting edema ○ Collateral superficial veins
Yellow Flags	<ul style="list-style-type: none"> • Persistent reactive pain or effusion following therapy or ADLs <ul style="list-style-type: none"> ○ <i>Decrease intensity of therapy interventions, continue effusion management and provide patient education regarding activity modification until reactive symptoms resolve</i>

Protection Phase (Post-op – 6 weeks)

Precautions	<ul style="list-style-type: none"> • Maintain post-operative splint or cast per surgeon (if splint or cast is not removable, then treatment will only be initiated at proximal joints) • NWB x 6-8 weeks (or as directed by surgeon)
ROM	<ul style="list-style-type: none"> • Soft tissue mobilization to gastrocnemius-soleus complex with caution near incision and site of fixation/repair <ul style="list-style-type: none"> ○ Do not neglect mid-substance region of Achilles and other associated soft tissue regions • Initiate PROM <ul style="list-style-type: none"> ○ PF as tolerated ○ DF to minimal stretch, DO NOT aggressively stretch <p><i>*Only performed if patient is in removable splint or cast</i></p>
Weight Bearing	<ul style="list-style-type: none"> • NWB x 6-8 weeks (or as directed by surgeon) <ul style="list-style-type: none"> ○ Refer to surgeon's post-operative report or office visit note for specific instructions on weight bearing
Therapeutic Exercise	<ul style="list-style-type: none"> • Initiate foot intrinsic exercises: <ul style="list-style-type: none"> ○ Toe taps ○ Arch doming ○ Toe spreading ○ Towel scrunches • Towel crunches • Ankle PROM performed by therapist • SLR 4-way • Exercise Bike (with boot) <p><i>*All exercises should be pain-free; only performed if patient is in removable splint or cast</i></p>
Goals	<ul style="list-style-type: none"> • Reduce edema • Manage pain • Ensure closure of incision and assess for signs/symptoms of infection <ul style="list-style-type: none"> ○ Monitor for skin integrity complications, such as, slow healing wounds or decubital ulcers, that are common with this surgery and patient population • Educate on DVT/thromboembolism, weight bearing status and precautions



Early Loading Phase (6-12 weeks)

Precautions	<ul style="list-style-type: none"> • DF AAROM/AROM to minimal stretch, DO NOT aggressively stretch to pain
ROM	<ul style="list-style-type: none"> • Initiate pain-free AROM plantarflexion, inversion, eversion; continue PROM • Joint mobilizations: improve accessory motions at subtalar, distal tibiofibular, midfoot, and forefoot joints as needed
Weight Bearing	<ul style="list-style-type: none"> • Initiate WBAT with crutches in walker boot starting post-op Week 6-8 per surgeon • Discharge crutches when gait normalized • Week 6-8: Begin to wean out of boot, initiate walking in shoe/neutral ankle position • Use of heel wedges (≤ 2) in shoe as needed: start with number of wedges where no pain is felt and patient demonstrates proper gait mechanics, remove as able
Therapeutic Exercise	<p>Early Exercises</p> <ul style="list-style-type: none"> • Submaximal ankle isometrics all planes • BAPS board seated • Recumbent bike with CAM boot • UBE for cardiovascular endurance • Gluteal and lumbopelvic strength and stability <p>Late Exercises</p> <ul style="list-style-type: none"> • Progressive resisted PF, inversion, and eversion with theraband • Seated heel raises with light weight • Initiate balance/proprioceptive training on stable surface once able to weight bear in neutral ankle position out of boot • Standing BAPS board as tolerated: PWB → FWB • Light CKC Strengthening <ul style="list-style-type: none"> ○ Double -> Single Leg Press ○ Squat • RDL
Other Suggested Interventions	<ul style="list-style-type: none"> • May initiate soft tissue mobilization and incisional mobility after adequate wound closure • Pool therapy may begin at post-op week 6 (if wound closed and able to weight bear in neutral ankle position out of boot)
Criteria to Discharge Walking Boot	<ul style="list-style-type: none"> • <u>ROM</u>: Able to achieve 0° DF • <u>Weight Bearing</u>: Demonstrates pain-free ambulation without analgic gait • <u>Timeframe</u>: Full discharge from boot and heel lifts by Week 10
Goals	<ul style="list-style-type: none"> • Gradual wean from boot and lifts with goal of ambulation in supportive shoe by Week 10

Heavy Loading Phase (12-18 weeks)



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Precautions	<ul style="list-style-type: none"> • DF P/AROM to mild stretch, DO NOT aggressively stretch
ROM	<ul style="list-style-type: none"> • Achieve full PROM/AROM plantarflexion, inversion, eversion • Joint mobilizations: improve accessory motion at subtalar, distal tibiofibular, midfoot, and forefoot joints as needed
Therapeutic Exercise	<p>Early Exercises</p> <ul style="list-style-type: none"> • Initiate balance training on unstable surfaces • Continue BAPS standing as tolerated within pain-free ROM, increasing level as able • Progressive hip and knee strengthening per patient's tolerance • Recumbent bike in shoe • Initiate calf raise progression on shuttle: <ul style="list-style-type: none"> ○ Double leg → 2 up 1 down → single leg ○ Starting position: neutral ankle → dorsiflexion <p>Late Exercises</p> <ul style="list-style-type: none"> • Initiate standing heel raise progression as able <ul style="list-style-type: none"> ○ Double leg → 2 up 1 down → single leg ○ Starting position: neutral ankle → dorsiflexion • Initiate step holds with focus on lower extremity alignment and balance (within available DF) <p>Initiate heel taps (within available DF)</p>
Goals	<ul style="list-style-type: none"> • Initiate higher level lower extremity strengthening exercises • ≥ 10 single leg heel raises with heel height within 20% of uninvolved limb

Return to Function Phase (18 weeks-Return to Sport)

Precautions	<ul style="list-style-type: none"> • None
ROM	<ul style="list-style-type: none"> • May initiate gastrocnemius-soleus complex stretching as needed to restore DF ROM • Joint mobilizations and soft tissue mobility as needed
Weight Bearing	<ul style="list-style-type: none"> • Normalized gait mechanics • Reciprocal pattern with stair ascent and descent
Therapeutic Exercise	<ul style="list-style-type: none"> • Emphasize strengthening at end-range PF <ul style="list-style-type: none"> ○ Heel raises on decline board (starting in plantarflexed position) ○ Resisted inversion and eversion in plantarflexed position (theraband or ankle weight) ○ DL heel raises with theraband pulls into ankle inversion and eversion ○ Toe walking • Heels raises in knee flexion • Continued progression of strength/stability/balance exercise on stable and unstable surfaces to correct altered mechanics • Initiate plyometric progression: <ul style="list-style-type: none"> ○ Shuttle press: DL → alternating → SL ○ FWB: DL straight plane → diagonal plane → rotational → tuck jumps → SL • Step/hop holds for training on lower extremity landing mechanics for jogging • Resisted jogging in place with resistance in all planes • Sports specific exercise/agility progression, emphasis on proper mechanics
Criteria to Initiate Return to Running and Jumping	<ul style="list-style-type: none"> • <u>ROM</u>: 95% symmetry ROM (DF/PF) compared to uninvolved limb • <u>Anthropometrics</u>: 95% symmetry calf circumference at 10 cm distal to tibial tubercle compared to uninvolved limb • <u>Weight Bearing</u>: Normalized gait and jogging mechanics • <u>Strength</u>: 25 single leg heel raises with heel height within 20% of uninvolved limb • <u>Timeframe</u>: Initiate between Weeks 12-16
Criteria for Return to Sport	<ul style="list-style-type: none"> • <u>ROM</u>: 95% symmetry ROM (DF/PF) compared to uninvolved limb • <u>Weight Bearing</u>: Normalized gait and jogging mechanics • <u>Strength</u>: ≤10% plantarflexor asymmetry at 0° DF and ≤25% asymmetry at 20° PF with handheld dynamometer compared to uninvolved limb (Appendix A) • <u>Neuromuscular Control</u>: 90% symmetry between limbs on Y-balance test with appropriate lower extremity mechanics • <u>Functional Hop Testing</u>: 90% symmetry SL hop testing (Appendix B) • <u>Physician Clearance</u> • <u>Timeframe</u>: Initiate between 6-9 months

Appendix A: Hand-Held Dynamometry for Ankle Plantarflexion



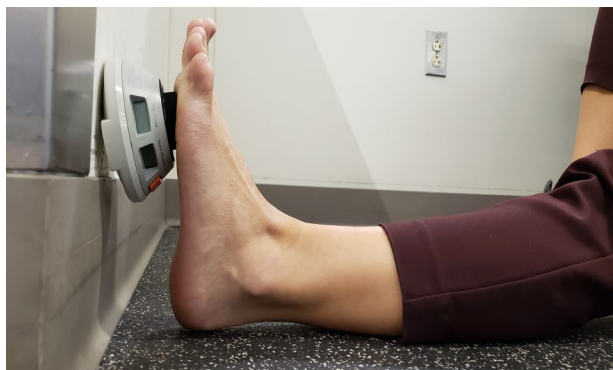
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Position	<ul style="list-style-type: none"> • Patient in long-sit position on non-slip floor with foot against wall; barefoot • Knee is fully extended
Placement	<ul style="list-style-type: none"> • Hand-held dynamometer placed between wall and foot, against plantar surface of foot just proximal to the metatarsal heads • Stabilize lower leg just proximal to ankle as needed
Protocol	<ul style="list-style-type: none"> • Testing performed at 0° DF and 20° PF • 3 isometric contractions performed in each position lasting 3-5 seconds each • Minimum 10 second rest between trials, 1 minute rest between testing angles • Take average of the 3 trials at each angle • Determine symmetry index for each angle: $(\text{involved/uninvolved}) \times 100 = \% \text{ symmetry}$
Goal	<ul style="list-style-type: none"> • 0° DF: $\leq 10\%$ asymmetry between limbs • 20° PF: $\leq 25\%$ asymmetry between limbs

0° dorsiflexion



20° plantarflexion



*Measurements obtained via hand-held dynamometry with always yield lower values than formal Biodex testing. The numbers obtained from hand-held dynamometry are best utilized to determine level of symmetry between involved and uninvolved limbs versus as an accurate representation of force production.

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Appendix B: Single Leg Hop Series

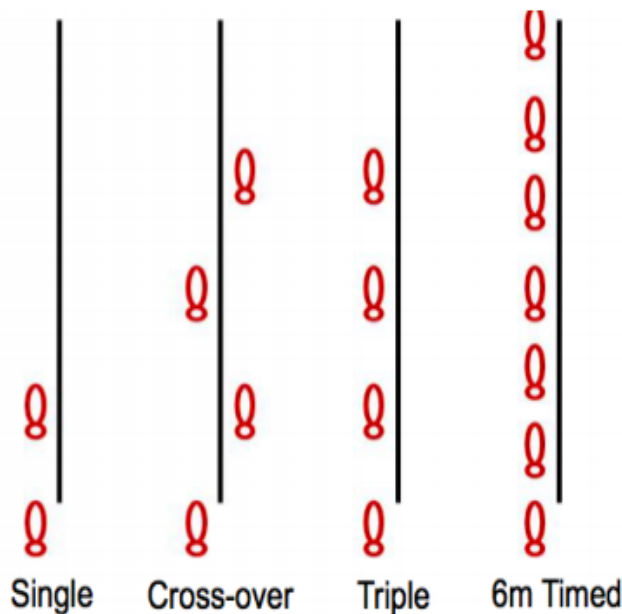


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- 1) **Single hop for distance:** Have the subject line their heel up with the zero mark of the tape measure, wearing athletic shoes. The subject then hops as far as he/she can, landing on the same push off leg, for at least 3 seconds. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: $\text{Involved limb distance} / \text{Uninvolved limb distance} \times 100\%$.
- 2) **Cross-over hop for distance:** The subject lines their heel up with the zero mark of the tape measure and hops 3 times on one foot, crossing fully over the center line each time. Each subject should hop as far forward as he/she can on each hop, but only the total distance hopped is recorded. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: $\text{Involved limb distance} / \text{Uninvolved limb distance} \times 100\%$.
- 3) **Triple hop for distance:** The subject lines their heel up with the zero mark of the tape measure and hops 3 times on one foot. Each subject should hop as far forward as he/she can on each hop, but only the total distance hopped is recorded. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: $\text{Involved limb distance} / \text{Uninvolved limb distance} \times 100\%$.
- 4) **Timed 6-meter hop:** The subject lines their heel up at the zero mark of the tape measure and hops, on cue with the tester, as fast as they can the length of the 6-meter tape. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: $\text{Involved limb time} / \text{Uninvolved limb time} \times 100\%$.



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