Cavovarus Foot Treatment Guidelines Handout

Cavovarus foot is a complex structural condition defined by a high medial arch (cavus) and inward heel tilt (varus). This deformity impacts foot biomechanics, leading to pain, instability, and functional challenges. While it may develop due to neuromuscular disorders like Charcot-Marie-Tooth (CMT) disease or traumatic injuries, a comprehensive, personalized approach to treatment can significantly improve outcomes. These guidelines offer a structured framework for the management, and treatment of cavovarus foot.

Non-surgical management

Conservative treatment is often the initial approach to managing parvovirus foot, particularly in cases with mild or flexible deformities. Although parvovirus foot tends to progress, early-stage non-surgical interventions can alleviate symptoms and delay surgical interventions.

Activity modification

Patients are encouraged to reduce high-impact activities that exacerbate symptoms. Simple lifestyle changes, such as avoiding prolonged standing or walking without adequate foot support on uneven surfaces, can alleviate pain and reduce the risk of complications like lateral ankle instability.

Custom orthoses and accommodative shoes

Custom orthoses play a pivotal role in redistributing pressure and correcting alignment. For flexible cavus feet, orthoses with lateral hindfoot posting and a recess for the first metatarsal head and heel pad are effective in realigning the hindfoot and offloading lateral foot pressure. Evidence from a randomized controlled trial of 154 patients with painful pes cavus showed statistically significant improvements in pain scores, foot function, and quality of life among patients using custom orthoses compared to those using sham orthoses (Burns et al., 2006). More rigid deformities may require restrictive orthoses, such as Arizona braces, to provide additional stability and support.

Physical therapy and rehabilitation

Physical therapy is essential for strengthening weak muscles and stretching tight structures like the gastrocnemius and plantar fascia. Gastrocnemius stretching programs can prevent contractures, and strengthening exercises for the anterior tibialis and peroneus brevis improve functional outcomes. A study of a 12-week lower extremity strengthening program reported significant increases in dorsiflexion strength (56% to 72%) and plantarflexion strength (15% to 20%), alongside improved functional outcomes (Burns et al., 2009).

Pharmacological management

Nonsteroidal anti-inflammatory drugs (NSAIDs) are commonly prescribed to alleviate pain and inflammation. For cases with spasticity-driven deformities, muscle relaxants like baclofen or botulinum toxin injections may be employed. Although a trial by Burns et al. (2010) in children with Charcot-Marie-Tooth disease found botulinum toxin safe and well-tolerated, it showed limited efficacy in halting deformity progression.

Splinting and casting

In pediatric patients, nocturnal splinting or casting can delay surgical intervention. A cohort study demonstrated that splinting or casting delayed surgery by an average of 4.5 years in 11 out of 35 feet with neurological cavus deformities, with most patients avoiding surgery entirely during a 4.5-year follow-up period (d'Astorg et al., 2016).

Surgical treatment guidelines

The primary objective of surgical treatment for cavovarus foot is to achieve a painless, plantigrade, and functional foot. Effective surgical intervention requires careful planning, guided by a comprehensive understanding of the patient's unique anatomy, physical examination findings, and imaging results. Importantly, anatomical abnormalities alone do not explain the cause of each deformity component, necessitating a personalized surgical plan tailored to the patient's specific condition.

Tailored surgical approaches

- **Short-course deformities**: In cases caused by acute conditions such as stroke or brain trauma, where deformities primarily involve muscle imbalances and soft tissue contractures without significant bony changes, treatment emphasizes restoring muscle balance through procedures such as tendon transfers and soft tissue releases. These cases, however, are less common.
- **Chronic and rigid deformities**: Most patients present with long-standing conditions resulting in stiff or rigid bones. These cases necessitate a combination of procedures, including osteotomies to realign bony structures, tendon transfers to restore muscle balance, and ancillary interventions to address associated deformities like claw toes or hallux valgus.

Soft-tissue release

Soft-tissue release is an essential surgical step to improve flexibility and prepare the foot for further corrective procedures. It targets tight or overactive tissues causing deformity and helps achieve a more natural foot alignment.

- **Plantar fasciotomy:** The plantar fascia is a band of tissue running along the bottom of the foot, and tightness or contracture in this structure can lead to rigidity and foot shortening. A plantar fasciotomy involves cutting the fascia to relieve tension. By doing so, the arch becomes more flexible, and the foot is better prepared for additional corrective surgeries like bone realignment. This procedure is particularly effective in improving the upward movement (dorsiflexion) of the first toe.

- **Achilles tendon lengthening and gastrocnemius recession::** When the Achilles tendon or calf muscles are overly tight, the heel is pulled upward, causing a condition called hindfoot or ankle equinus . This can worsen the deformity and make walking more challenging. Through methods like open Z-plasty or percutaneous (small incision) techniques, the tension in these tissues is reduced.
- **Additional soft-tissue releases:** For more severe deformities, releasing other tight tissues may be necessary:
  - **Posterior tibialis tendon release**: This tendon, located on the inside of the ankle, can contribute to inward rolling of the heel (varus deformity). Releasing it helps improve alignment.
  - **Deltoid ligament release**: Sometimes the ligaments on the inner ankle need to be addressed to correct tightness and restore proper movement.

Summary of soft-tissue release techniques

Condition/Deformity	Procedure	Purpose/details
Contracture of the plantar fascia	Open or percutaneous plantar fasciotomy	Releases tension in the plantar fascia to improve foot flexibility and reduce rigidity.
Overpull of the intrinsic muscle	Steindler stripping	Reduces excessive tension caused by intrinsic muscle overpull to aid in balancing foot dynamics
Ankle equinus deformity	Gastrocnemius recession Achilles tendon lengthening	Lengthens the calf muscle to reduce upward heel pull and enhance dorsiflexion. Loosens the Achilles tendon to address the hindfoot equinus and improve alignment.
Ankle varus deformity	Lateral ankle ligament reconstruction Deltoid ligament release	Stabilizes the lateral ankle and corrects inward rolling (varus) of the heel. Relieves medial ankle tension contributing to varus alignment
Severe rigid deformity	Combined with other tendon release procedures	A combination of soft-tissue releases (e.g., plantar fascia, posterior tibialis) to address extreme rigidity.

Bony reconstruction

Bony reconstruction is a cornerstone of surgical intervention for cavovarus foot deformities, aimed at correcting structural misalignments, restoring a plantigrade foot, and achieving optimal functionality. Reconstruction strategies vary based on the apex of the deformity—forefoot, midfoot, or hindfoot—and often involve osteotomies or arthrodesis. Accurate preoperative assessment, including X-ray imaging and osteotomy angle calculation, is essential to plan the most effective intervention.

Forefoot-driven cavus foot

For deformities centered at the forefoot, particularly around the first tarsometatarsal (TMT) joint, correction often involves a first metatarsal dorsiflexion osteotomy. This procedure addresses the excessive plantarflexion of the first ray by removing a dorsal wedge of bone, thereby elevating the metatarsal to restore alignment. Studies, such as those by Giannini et al., confirm this approach effectively reduces forefoot-driven cavus deformities while minimizing risks like metatarsal shortening. However, in cases where multiple metatarsals contribute to the deformity, the Jahss tarsometatarsal truncated-wedge arthrodesis is more appropriate. This technique elevates the entire forefoot while correcting rotational or adduction deformities, preventing further complications such as metatarsalgia.

Midfoot deformities

Midfoot deformities often require more extensive correction through osteotomies like the Cole, Japas, Akron, or Myerson procedures. Each technique targets the midfoot apex and varies based on the deformity's characteristics:

- **Cole osteotomy**: Removes a dorsal wedge from the cuboid and cuneiforms to reduce arch height and improve flexibility. Studies by Tullis et al. highlight its success in restoring normal foot function and alignment.
- **Japas osteotomy**: Involves a V-shaped cut extending distally through the cuboid and medial cuneiform, allowing for arch realignment and correction of forefoot adduction or abduction. Protyush Chatterjee's work demonstrates its effectiveness in adolescents with poliomyelitis-induced cavus foot.
- **Akron osteotomy**: Features dome-shaped cuts that raise the forefoot and reduce equinus. This method allows for precise three-dimensional corrections, as detailed by Weiner et al.
- **Myerson osteotomy**: Combines multiple osteotomy lines for multiplanar correction, ensuring improved flexibility and alignment of the midfoot.

For severe or complex midfoot deformities, the Ilizarov external fixation method is an alternative. This minimally invasive technique employs an external frame to guide gradual realignment, providing dynamic, three-dimensional corrections while preserving joint integrity.

Hindfoot deformities

When the deformity is centered at the hindfoot, calcaneal osteotomies are commonly employed:

- **Dwyer osteotomy**: Addresses mild nonreducible heel varus by removing a lateral wedge from the calcaneus to correct valgus alignment. Krause et al. report reduced medial joint pressures and improved gait stability with this technique.

- **Z-shaped osteotomy**: Used for severe varus deformities, this complex, multiplanar correction involves precise cuts to adjust rotation, elevation, and alignment. Pfeffer et al. emphasize its effectiveness but caution that careful surgical planning is required to avoid complications.

Mixed deformities

In cases where the deformity involves both the forefoot and hindfoot or is complicated by joint degeneration, arthrodesis procedures are indicated. Double or triple arthrodesis stabilizes the foot by fusing key joints, including the subtalar, talonavicular, and calcaneocuboid. While effective in providing pain relief and structural stability, this approach carries a risk of adjacent joint degeneration, as highlighted by long-term follow-ups conducted by Saltzman et al. For localized deformities at the naviculocuneiform (NC) joint, naviculocuneiform arthrodesis is preferred to restore medial arch alignment and prevent further collapse.

Soft-tissue balancing techniques for cavovarus foot

Soft-tissue balancing is a crucial component of cavovarus foot correction, aiming to address muscle imbalances and deforming forces that contribute to the progression of the condition. These procedures not only enhance foot stability but also optimize alignment and functional outcomes. The approach is highly individualized, depending on the patient’s specific muscle weaknesses and deforming forces.

Peroneus longus to brevis transfer

When the peroneus brevis is weakened or degenerated, the peroneus longus tendon can be transferred to augment lateral ankle stability. This procedure reduces the plantarflexion force on the first ray, as shown in Rosenbaum et al.’s biomechanical analyses, and significantly decreases deformity progression.

Posterior tibial tendon transfer

Overpowering of the posterior tibial tendon causes excessive inversion and heel varus. Transferring this tendon to the lateral cuneiform or cuboid restores dorsiflexion and eversion forces. Clinical studies by Saltzman et al. report substantial improvements in varus correction, gait function, and prevention of recurrence.

Claw-toes deformity

- **Jones procedure**
  For claw-toe deformities, the Jones procedure involves releasing the extensor hallucis longus tendon and transferring it to the first metatarsal neck. This reduces extensor overpull while stabilizing the toes, as evidenced by Giannini et al.'s clinical data showing improved alignment and reduced pain.
- **Hibbs procedure**
  The Hibbs procedure transfers the extensor digitorum longus tendons to the lateral cuneiform, correcting claw toes and aiding dorsiflexion. Studies validate this technique’s effectiveness in improving weight distribution and forefoot stability, thereby enhancing functional outcomes during walking.

Summary of soft-tissue balancing techniques

Condition/deformity	Procedure	Purpose/details
Weakness of peroneus brevis	Peroneus longus to brevis transfer	Stabilizes the lateral ankle and reduces plantarflexion of the first ray.
Overpower of posterior tibial tendon	Posterior tibial tendon transfer	Balances deforming forces, corrects heel varus, and improves gait by augmenting dorsiflexion and eversion.
Claw-toe deformities	Jones procedure	Addresses claw-toe deformities by transferring extensor forces and fusing distal joints for stability.
	Hibbs procedure	Realigns claw toes and enhances dorsiflexion by transferring extensor tendons to the lateral cuneiform.

Integration with bony reconstruction

Soft-tissue balancing is often performed alongside bony reconstruction to ensure comprehensive correction. Without addressing muscle imbalances, bony procedures alone may fail to achieve long-term stability. For example, a peroneus longus to brevis transfer is frequently paired with calcaneal osteotomy to ensure both structural and functional correction. Similarly, the Jones procedure may accompany midfoot osteotomies to address forefoot-driven cavus.

By combining soft-tissue balancing with structural corrections, these interventions help restore a functional and plantigrade foot, improving patient outcomes and preventing recurrence.

Additional notes

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