

# CUBOID SYNDROME

*Richard J. Zirm, D.P.M.*

Cuboid syndrome is a common, but poorly recognized condition defined as a minor disruption or subluxation of the structural integrity of the calcaneocuboid portion of the midtarsal joint. The normal dorsal/plantar joint motion is reduced or absent when compared to the uninjured side. It is theorized that this occurs because of an abnormal inversion force to the rearfoot when the forefoot is loaded during closed chain kinetics. Dysfunction of the locking mechanism of the midtarsal joint has been implicated as the underlying cause. Radiographs and other imaging modalities seldom reveal consistent findings. The diagnosis is primarily subjective based on the patient's history and physical findings, and successful treatment requires recognition of the deformity. Pain is relieved with manipulation of the cuboid to restore its normal, functioning position. Follow-up is then used to insure that the cuboid remains in its anatomic position.

A lack of information concerning cuboid subluxation is present in the orthopedic, physical medicine, podiatric, and rehabilitation literature. Newell and Woodle were the first podiatrists to document the condition in 1981.<sup>1</sup> However, joint manipulation techniques were first described in the osteopathic literature.<sup>2</sup> Physicians working with professional ballet companies have assembled much data on this commonly-occurring injury.<sup>3</sup>

### INCIDENCE

Cuboid syndrome has also been listed in the literature as locked cuboid, subluxed cuboid, calcaneocuboid syndrome, dropped cuboid, calcaneocuboid fault syndrome, and lateral plantar neuritis. Newell and Woodle reported a 4% incidence of cuboid syndrome in a review of 3,600 athletes with foot injuries.<sup>1</sup> However, Marshall and Hamilton<sup>3</sup> documented a 17% incidence of cuboid subluxations in two separate three-week periods, charting the injuries sustained by dancers of the American Ballet Theater. A recent surge in the incidence and diagnosis of cuboid syndrome has

been attributed to the increase of heel surgery utilizing the endoscopic plantar fasciotomy technique that promotes a rapid return to a high activity level.

### SIGNS AND SYMPTOMS

Presenting complaints are sharp pain localized at the lateral aspect of the foot at the level of the calcaneal cuboid joint. The pain can occasionally occur at the cuboid-fourth and fifth metatarsal articulations, and infrequently along the cuboid-lateral cuneiform/cuboid-navicular articulations. The patient relates that following the precipitating injury, the pain is either gradual or rapid often becoming a chronic "inability to work through" the injury. There is continued pain primarily during the propulsive phase of gait which impairs walking, and can become disabling. Eventually the symptoms can be difficult to diagnose because of referred pain and generalized foot pain.

Since the diagnosis of cuboid syndrome often remains enigmatic, the differential diagnosis should include stress fracture of the cuboid or fifth metatarsal base, calcaneonavicular coalition, peroneal tendinitis/subluxation, symptomatic os peroneum, plantar fasciitis, calcaneal beak fractures, or sinus tarsi syndrome. More serious injuries involving fracture, dislocation, and severe subluxation of the cuboid are rarely missed and usually require acute surgical treatment.

The physician can usually elicit pain and tenderness in a patient with cuboid syndrome by directly palpating the peroneal groove plantarly with the examiner's thumb (Fig. 1). Manipulation of the calcaneocuboid joint, extensor digitorum brevis origin, and peroneus longus tendon plantarly, can also elicit pain and tenderness. A consistent finding is pain produced by longitudinal midtarsal joint supination. Severely subluxed cuboids can leave a shallow, visible depression on the dorsal aspect of the cuboid, and a plantar fullness. Mild edema is a consistent finding, whereas ecchymosis and redness are rare. The diagnosis can be confirmed

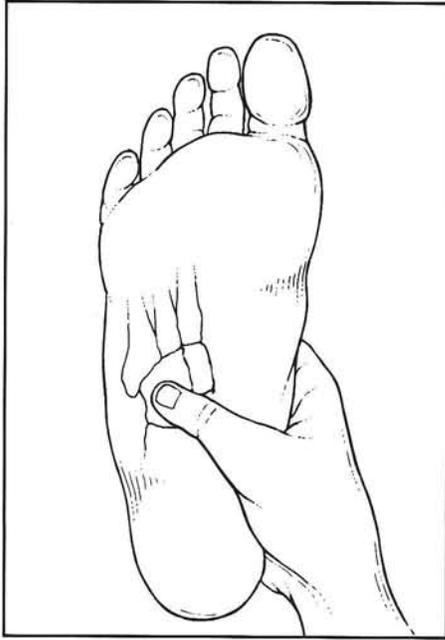


Figure 1. Pain and tenderness is elicited upon palpation of the peroneal groove, plantarly.

by having the patient resist inversion of the foot, using the peroneus brevis to abduct the foot, and the peroneus longus to plantarflex the first metatarsal, which is held in dorsiflexion and supination by the examiner's hand.<sup>4</sup>

Pain along the peroneus longus as it courses in the peroneal groove underneath the cuboid, is characteristic for the injury. Occasionally, pain and instability at the cuboid and fourth and fifth metatarsal bases with an audible click can be palpated. Similarly, there may be crepitus at the calcaneocuboid articulation, with a sensation of locking or catching.

Various imaging modalities are unable to aid in the diagnosis of the condition because of the subtleness of the variations of the findings. Repeated attempts to document the diagnosis by radiographs, computerized axial tomography (CT) scans, or magnetic resonance imaging (MRI) studies have been unsuccessful because of normal variations between the cuboid and its surrounding structures.<sup>3</sup> However, in a recent radiological case study, Everson et al. noted that the incongruity of the calcaneocuboid joint space was identified when the space between the calcaneus and cuboid deviated from 2.0 millimeters with gapping dorsally (> 2.0 mm.) and jamming plantarly (< 2.0 mm).<sup>5</sup> This study was performed on non-weight bearing subjects, and it is the author's opinion that the radiologists involved in the study "read into" the subtle radiographic findings.

## PATHOMECHANICS

Previous attempts to correlate a specific foot type or injury pattern with the onset of cuboid syndrome has been limited to the experience or patient base of the reporting physician. It is evident that the mechanics of the condition appear to be an eversion of the cuboid from an inverted foot position. This can occur in the following three scenarios 1) following an inversion sprain of the foot or ankle, 2) walking in a supinated position, such that occurs in a cavus foot with anterior equinus and a plantarflexed lateral column, 3) a pronated foot with a plantarflexed lateral column that has excessive lateral pressure at the midfoot.

The specific, etiologic mechanism responsible in all of the preceding scenarios resulting in cuboid subluxation is that they all allow a greater mechanical advantage of the peroneus longus, which makes it easier to sublux the cuboid. A forceful contraction of the peroneus longus muscle creates a medial frontal plane rotation of the cuboid. The peroneus longus tendon glides within a thick, fibro-osseous tunnel on the underside of the cuboid. This imparts a dorsal and lateral rotatory force on the cuboid, subluxing it inferomedially around a plantar medial axis (Fig. 2).<sup>6</sup> Injury to the intertarsal ligaments, especially the thinner, taut dorsomedial ligaments, predisposes the cuboid to plantar subluxation. The cuboid has been described as a

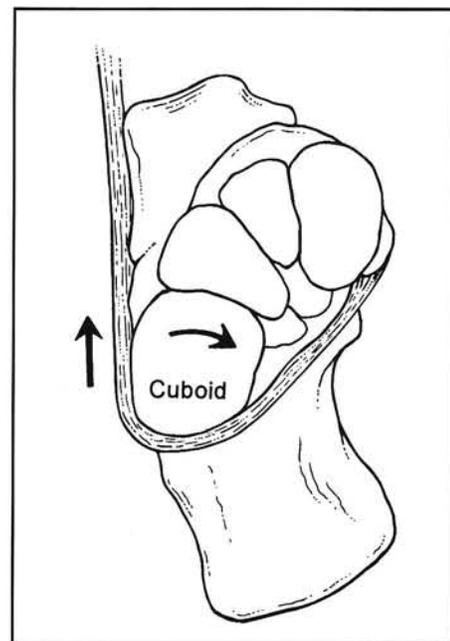


Figure 2. The force of the peroneus longus tendon causes a rotatory force around a plantar-medial axis subluxating the cuboid plantarly.

fulcrum and the peroneus longus tendon as the pulley device which normally plantarflexes the first ray but pathologically pulls the lateral aspect of the cuboid dorsally. This allows the medial aspect to shift to a more plantar position essentially "locking" the joint out of functioning alignment. The joint can not move through its full range of motion, the midtarsal joint locking mechanism is impaired, and the patient experiences significant pain.

Therefore, the basic underlying condition that predisposes the cuboid to sublux by the abnormal pull of the peroneus longus is the dysfunction of the midtarsal joint. Specifically, the calcaneal cuboid joint whose congruity influences the locking mechanism of the midtarsal joint.<sup>7</sup> The prerequisite for the locking of this joint is that the calcaneal process of the cuboid fits closely into its adjoining recess, and that the dorsal border of the calcaneus overlaps the cuboid, thus stopping excessive pronation of the forefoot on the rearfoot. During normal function in the stance phase of gait, pronation of the forefoot on the rearfoot allows the forefoot to adapt to uneven surfaces. In reality it is not the forefoot moving on the rearfoot but, the rearfoot moving on the forefoot. Thus, during propulsion, an individual with incomplete calcaneocuboid congruity excessively pronates the midtarsal joint resulting in excessive ground reactive forces that overwhelm the ligaments and joint capsule. This results in acute or chronic stress to the ligaments supporting the calcaneocuboid joint, resulting in a subluxed, displaced cuboid. Cuboid syndrome results from this subtle joint malalignment which irritates the joint capsule, ligaments, and the peroneus longus tendon.

A consistent finding is cuboid syndrome in patients who are recovering from heel spur surgery, specifically, endoscopic plantar fasciotomy. Approximately 20% to 25% of these patients present with cuboid syndrome at two to four weeks following their surgery, once their walking increases. It is apparent that these patients will often walk in a supinated position, either consciously or unconsciously to guard the tender, medial heel surgery site. Furthermore, when the plantar fascial release is complete to the lateral aspect of the calcaneus, additional stress is applied to the long and short calcaneocuboid ligaments resulting in instability of the lateral column of the foot. These two factors predispose the patient to both calcaneocuboid joint instability and an

abnormally advantaged and prolonged pull of the peroneus longus. Postoperative cuboid syndrome can usually be prevented in the acute postoperative period by using a three to four week period of immobilization using a cam-walker type device, or even a short-leg walking cast.

Another biomechanical example that merits mention is in long distance runners with a functional forefoot valgus. The laxity of the medial column results in excessive pronation, which is treated with a full-length orthotic that posts the functional varus that occurs during running. It is this position that predisposes these patients to cuboid syndrome. The peroneus longus fires longer and with increased torque across a calcaneocuboid joint in an effort to increase the amount of plantarflexion at the ankle, thus improving speed and efficiency.<sup>4</sup>

A related theory of the etiology of cuboid syndrome is its development in ballet dancers, although there appears to be a difference in the cause between male and female dancers. In males, cuboid syndrome is usually the result of landing injuries when the dancer presumably pronates his foot or ankle. Thereafter, the previously described mechanism involving the peroneus longus applies. However, female dancers experience cuboid injuries more often from an overuse syndrome that creates an instability in the dorsal ligaments. It is theorized that when a female dancer goes from flat foot to full pointe, they can actually go beyond the full pointe position. The moment of force is reversed once she goes "over the top." This exerts a pathologic force that results in her dancing on the dorsal aspect of her toes and metatarsals. These constant, repeated force alterations eventually stress the ligament integrity, compromise the stability of the midfoot, and set the patient up for cuboid injury.<sup>3</sup>

## TREATMENT

Conservative treatment of cuboid syndrome is generally successful in realigning the displaced joint and relieving symptoms. The "cuboid whip" was originally introduced by Newell and Woodle in 1981.<sup>1</sup> Marshall modified the procedure in 1988 and named it the "cuboid squeeze."<sup>8</sup> Both are similar maneuvers that require the surrounding musculature be relaxed, including the long extensor as well as the peroneal tendons.

The cuboid squeeze and the cuboid whip are performed with the patient in the prone position, with a slightly flexed knee. An alternative is standing in the "horse-shoeing" position with the patient braced against a wall or chair. The patient's entire lower extremity must be fully relaxed. The examiner manipulates the foot and ankle into plantarflexion. The physician is facing the plantar aspect of the foot with thumbs on the medial plantar surface of the cuboid and fingers stabilizing the dorsal aspect of the foot, avoiding the dorsal aspect of the cuboid. When the physician feels the soft tissues relax, a small excursion, high velocity thrust is then directed dorsally at a 60 degree lateral angulation. The cuboid whip uses a more dramatic arc of motion than the more gradual, definitive cuboid squeeze. The squeeze maneuver allows the physician to feel the soft tissues relax, and relocate the cuboid in a controlled fashion (Fig. 3). The cuboid squeeze appears to be more effective than the cuboid whip. Forces are better controlled and the intensity is better directed. The whip technique transmits forces to the anterior ankle joint and can result in damage to the soft tissue structures, such as the peroneal nerves where they cross the ankle.



Figure 3. The proper patient position, hand placement, and direction of force in performing the cuboid squeeze.

An alternative technique can be used if the initial manipulation is unsuccessful. Performed with the patient supine, the physician stands at the base of the patient's feet and grasps the fourth and fifth metatarsals, while allowing gravity and the weight of the leg to distract the cuboid articulations (Fig. 4). After muscle relaxation is obtained, the metatarsals are pulled in a longitudinal direction

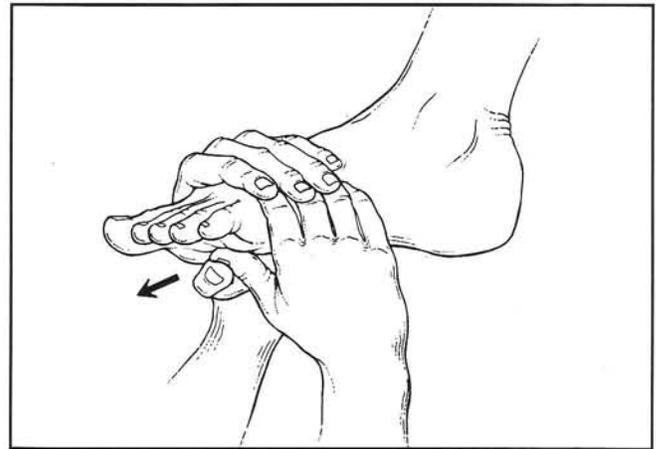


Figure 4. An alternative technique is to maintain the patient supine, and distract the fourth metatarsal. The cuboid reduces as a result of gravity.

with the forefoot in slight plantarflexion. This maneuver is also useful in relocating the subluxated cuboid metatarsal bases. This is accomplished with the fingers exerting a force in the plantar direction to the dorsal aspect of the metatarsal bases as the thumbs press dorsally at the plantar aspect of the involved metatarsal head(s).

Successful reduction is usually audible, however, not always. Most cases treated within 24 hours of injury will respond favorably with immediate and complete resolution of pain and dysfunction. Chronic cases will take longer for complete resolution with residual discomfort lasting for days following the maneuver. It is felt that the manipulations are successful greater than 90% of the time. If attempts to relocate an irreducible cuboid are unsuccessful, then it is recommended to commence manipulation at a later session and treat in the interim with ice and massage. Arthroplasty or arthrodesis is indicated very rarely, in chronically relapsing cases, or in completely irreducible joints that develop degenerative changes.

Following successful reduction, the patient should avoid vigorous activity for several days. Anti-inflammatory medications are helpful at this time. An 1/8 inch cuboid pad and low-dye strapping can be applied to help stabilize the midtarsal joint. Another taping technique uses two pieces of one-and-one-half-inch tape, beginning at the lateral rearfoot, around the posterior heel, plantarly under the cuboid, then over the proximal midfoot. The second strip is the same except for starting on the medial side and running the same

course as described in reverse. This is then secured with a wider strip of overlying tape. In patients with a biomechanically unstable foot (excessive pronation, uncompensated forefoot valgus), a neutral orthoses may be employed to help control mechanics and maintain proper joint alignment.

### CONCLUSION

Cuboid syndrome is a subtle, yet disabling subluxation of the structural congruity of the calcaneocuboid joint. The cause is an abnormal inversion force acting primarily on the rearfoot during closed chain kinetics when the forefoot is loaded just after heel-off. It is this abnormal force that acts upon a dysfunctional, "nonlocked" calcaneocuboid joint. The most consistent physical finding is joint pain elicited with longitudinal joint supination. Imaging studies are only useful to rule out more serious conditions. The treatment is primarily conservative, consisting of physical therapy, icing, taping, and neutral orthoses. Manipulation is generally well-tolerated and successful in relocating the joint and relieving symptoms.

Finally, the condition described occurs with consistent, demonstrable frequency in both the athletic and nonathletic populations. With awareness, the physician can identify and treat this problem with better efficiency. Much of the information regarding cuboid syndrome is anecdotal, with little documentation of actual cases and outcomes. Sports medicine specialists and foot and ankle surgeons alike are increasing their recognition of the problem and refining their treatment techniques.

### REFERENCES

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