

Cuboid Plantar and Dorsal Subluxations: Assessment and Treatment

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One of the most common traumatic lesions of the lower extremity is the inversion ankle sprain. A less recognized sequelae of an inversion stress at the ankle is injury to the joints and ligaments around the tarsal cuboid. Ligamentous injury can permit loss of joint congruency and alter joint motion. Motion at all synovial joints, and to some extent secondary cartilaginous joints, has two components: active physiological motion, defined as movement that can be voluntarily performed; and passive accessory motion, defined as a normally occurring joint movement that can not be reproduced voluntarily (5). Both components are essential for full pain-free range of motion of the joint (15). A normal joint will move through a certain range of active motion dictated by the shape of its articulating surfaces, the joint capsule, ligaments, and surrounding musculotendinous and bony structures (22). Normal range refers to the amount of motion available to a joint within its anatomic limits (22).

Joint range of motion is considered to be pathological when motion either fails to reach or exceeds the normal anatomic limits (5). Excessive movement beyond anatomic limits can only occur if there is damage to ligament or bone resulting in fracture, dislocation, or subluxation (3). Subluxation has been defined by Root et al (24) as a partial dislocation of a bone produced by motion that is

Plantar flexion and inversion stresses at the ankle may cause the tarsal cuboid to sublux in a plantar or dorsal direction resulting in pain and impaired joint function. Subluxation of the tarsal cuboid alters the passive physiological motion and accessory glides of the cuboid joints in characteristic patterns of motion restriction. Identification of the pattern of motion restriction is necessary for appropriate diagnosis and treatment. This paper presents the case reports of two patients with lateral foot pain. A subluxed cuboid bone was believed to be the cause of the patient's pain. Assessment and treatment are described and possible pathomechanics for cuboid subluxation are presented. Passive physiological motion of the cuboid and accessory joint glides should be assessed in patients complaining of lateral foot pain or with inversion ankle injuries. Pain and joint impairment can be alleviated with proper assessment and treatment.

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contrary to the plane of motion, or that exceeds the range of motion for that joint.

Little information exists in the medical literature pertaining to subluxed or partially dislocated cuboid bones (17,18,21). In comparison, there are more reports of dislocated cuboids (4,7-9,20), but even these cases are rare. All cases in the literature of partial or complete dislocation of the cuboid bone describe a plantar displacement. In clinical practice, the authors have found that patients can present with tarsal cuboid subluxation in a plantar or dorsal direction.

Identification of altered joint motion and differentiation of the direction of subluxation is based largely on the assessment of accessory joint glides and passive physiological motion tests. Clinical observations suggest that these techniques are useful to detect joint motion re-

strictions in the lateral side of the foot. The reliability and validity of these tests have not yet been established by controlled studies.

ANATOMY AND MOTION

The foot can be divided transversely into the hindfoot, midfoot, and forefoot (22), and longitudinally into medial and lateral functional units (7) (Figure 1). Posteriorly, the cuboid forms a synovial sellar shaped joint with the calcaneus, the calcaneocuboid joint. Anteriorly, it articulates with the base of the fourth and fifth metatarsals. The anterior surface of the cuboid is sellar shaped and the tarsometatarsal joints are synovial (26). The medial side of the cuboid articulates with the lateral cuneiform and the navicular. The calcaneocuboid joint is synovial, larger, and more anterior to the smaller brous cubonavicular joint (15,26).

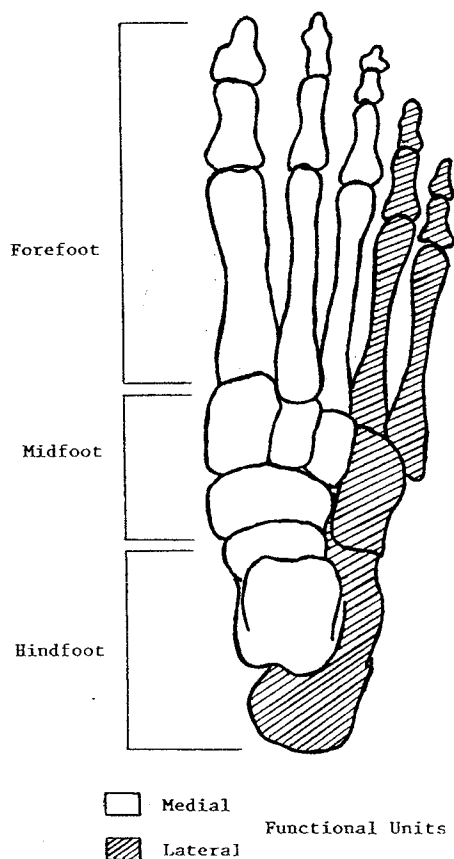


FIGURE 1. Functional units of the foot.

These two joints form a medial planar joint surface that is directed obliquely inferomedially. Motion permitted at the cuboid articulations is gliding with conjunct rotation (15).

Dictated by the osseoligamentous anatomy, the passive physiological motion of the lateral functional unit of the foot consists of two combined movement patterns: 1) plantar flexion and adduction with inversion (Figure 2), and 2) dorsiflexion and abduction with eversion (Figure 3). The accessory joint glide of the medial cuboid joint is dorsal glide with conjunct external rotation in the former pattern, and plantar with conjunct medial rotation in the latter (Figure 4).

Assessment of the passive physiological motion of the lateral functional unit of the foot and accessory joint glides is essential to the diagnosis and treatment of a tarsal cuboid subluxation. The purpose of this pa-



FIGURE 2. Assessment of passive physiological mobility and accessory joint glide of the lateral functional unit of the foot in plantar flexion, adduction, and inversion.



FIGURE 3. Assessment of passive physiological mobility and accessory joint glide of the lateral functional unit of the foot in dorsiflexion, abduction, and eversion.

per is to present the case reports of two patients: one with a plantar subluxed cuboid and one with a dorsal subluxed cuboid bone. Descriptions of the assessment and manipulative treatments for the cuboid are given and possible pathomechanics are addressed.

CASE REPORTS

Plantar Subluxed Cuboid

A 37-year-old female complained of persistent pain on the lateral side of her right foot with walking. She reported the onset of pain after



FIGURE 4. Passive accessory joint glide assessment of the medial cuboid joint in a plantar and dorsal direction.

twisting her ankle while walking 13 months prior. She did not fall and was able to continue walking. The next day, she noticed her foot was swollen and painful with weight bearing over the lateral midtarsals. The only other injury to the ankle was an inversion sprain when she was 16 years old. At the time of assessment, she was limited to wearing running shoes for comfort and was scheduled for a cortisone injection.

On visual observation of her gait, her right-side stride length was decreased, and she reported pain with each step at right heel lift. There was a visible depression over the tarsal cuboid area on the dorsal surface of her right foot. Palpation identified a very tender prominence in the center of her arch localized to the plantar surface of the cuboid. Ligament testing of the talocrural joint demonstrated anteroposterior laxity compared with the unaffected side, indicating a positive anterior drawer test (15). No laxity was apparent at the cuboid intertarsal or tarsometatarsal joints when a dorsal and plantar force was applied to the cuboid. Active range of motion at her ankles was equal bilaterally, and resistance testing was painfree.

Passive physiological mobility of

the lateral functional unit of the foot and accessory joint glides of the tarsal cuboid were assessed. A description of the tests follows:

Lateral Functional Unit of the Foot

Calcaneocuboid and the Medial Joint (Cubonavicular and Cuneocuboid Joints) on the Right Foot The patient is prone with his/her right knee flexed to 90°. The therapist stands on the patient's left side facing the foot. The left hand of the therapist stabilizes the calcaneus, while the right hand moves the lateral functional unit and the cuboid into combined plantar flexion, adduction and inversion with accessory dorsal glide and conjunct external rotation (Figure 2). This motion is then followed by dorsiflexion, abduction, and eversion, with accessory plantar glide and conjunct medial rotation (Figure 3).

Tarsometatarsal Joint (Base of the Fourth and Fifth Metatarsals on the Cuboid) The patient and therapist remain in the same position. The therapist moves each hand distally so that the left hand now stabilizes the cuboid and the right hand holds the fourth and fifth metatarsals as a unit; the metatarsals are then moved as the cuboid was above.

Medial Joint (Cubonavicular and Cuneocuboid Joints) Dorsal and Plantar Glides

The patient is supine and the therapist stands on the patient's right side. The medial side of the foot is stabilized by the therapist's left hand. The right hand, with the thenar eminence over the dorsum of the cuboid and the fingers on the plantar surface, applies a plantar and dorsal force in a medial and oblique direction producing a plantar and dorsal glide (12) (Figure 4).

Passive physiological mobility assessment revealed a loss of combined plantar flexion, adduction, and inversion; the medial cuboid joint had decreased accessory dorsal glide and conjunct external rotation on the right foot compared with the left side.

There were no abnormal neurovascular findings and roentgenographs found no bony abnormality.

The pattern of motion restriction found in the physical assessment indicated that her cuboid bone was subluxed plantar with medial rotation, and restricted motion in the opposite direction. A manipulative

Identification of altered joint motion and differentiation of the direction of subluxation is based largely on the assessment of accessory joint glides and passive physiological motion tests.

technique, defined as a low amplitude high velocity mobilization at the end of joint range, can be used to restore proper joint congruency and glide (5). Contraindications to manipulation, such as neoplastic or other bone disease, inflammatory arthritis, gout, neural or vascular abnormalities, were not present (10). She was treated with a manipulative reduction of the cuboid (Figures 5 and 6).

Manipulation for a Plantar Subluxed Cuboid

Newell and Woodle (21) described the "cuboid whip" technique for reduction of the cuboid. Marshall adapted the technique and called it the "cuboid squeeze" (17,18). For both techniques, the patient's position is prone on a bed with a flexed knee. The leg can also be dropped off the edge of the bed to flex the hip and the knee.

An alternate position is in standing, in the horseshoeing position with the hip in neutral and the knee flexed to 90°. The patient holds on to a chair or bed for balance (21) (Figure 5). The therapist faces the plantar surface of the patient's foot, and the therapist's thumbs are placed on the medial plantar surface



FIGURE 5. Horseshoeing position for manipulation of plantar cuboid.



FIGURE 6. Manipulation for plantar cuboid (the → indicates the direction of the force).

of the cuboid with the fingers on the dorsal side stabilizing the forefoot (the fingers must not be over the cuboid on the dorsal side). With the ankle in slight plantar flexion, a force directed dorsal about 60° laterally is applied to the medial side of the cuboid with a small amplitude high velocity thrust (Figure 6).

The term "whip" should not be used in the description of the technique, and any whipping of the foot should be avoided to reduce the risk of forces being transmitted to the talocrural joint. After manipulation, reassessment of the passive physiological motion and accessory joint glides of the cuboid at its articulations demonstrated increased range in the combined movements of plantar flexion, adduction, and inversion. Ice was applied to the lateral side of her foot for 10 minutes to reduce any inflammatory response and pain (13), followed by ultrasound treatment 0.5 W/cm² pulsed times 5 minutes to facilitate collagen synthesis (19). Her longitudinal arch was taped, as described by Arnheim (1), and she was requested to keep the tape on until the next visit. On the follow-up assessment 3 days later,

The ligaments of the cuboid were tested by imparting a dorsal and plantar stress to the cuboid.

she reported decreased pain when walking, although her foot was sore for a day after the initial treatment. She received six subsequent treatments consisting of the application of heat for 10 minutes and passive joint mobilization, performed like the passive physiological motion and accessory joint glide tests, to restore full joint glide and soft tissue mobility (12). The amplitude and duration of mobilizations were dictated by perceived tissue resistance and patient comfort. Ultrasound treatments to facilitate collagen synthesis (19) were continued and increased to 1 W/cm² continuous times 5 minutes (23). She performed graded intrinsic and extrinsic foot muscle exercises, stretches, and proprioceptive wobble board exercises, adapted from Reid's sprained ankle treatment protocol (23), to improve strength and coordination (2). Two months after the manipulation, she reported only minimal pain with prolonged walking and was able to wear other shoes comfortably.

Dorsal Subluxed Cuboid

A 14-year-old male basketball player complained of acute right-sided lateral foot pain after he landed on another player's foot and twisted his ankle. He was seen 2 days postinjury, nonweight bearing on crutches because of the pain in his foot.

On examination, pain and swelling were localized to the dorsolateral aspect of his foot over the cuboid

area. A small amount of bruising was noted inferiorly on the lateral side of the cuboid. There was a palpable bump on the dorsal aspect of the cuboid area with tenderness over extensor digitorum brevis. Ligament stress testing at the talocrural joint was negative. The ligaments of the cuboid were tested by imparting a dorsal and plantar stress to the cuboid. These tests were painful in both directions, but no laxity was detected. Active ankle and foot range of motion was visually estimated to be decreased by 80% in eversion and plantar flexion and by 50% in inversion and dorsiflexion. Resisted muscle testing of the ankle, as described by Magee (15), was strong and painful in eversion. Passive physiological mobility testing of the lateral functional unit and accessory joint glides of the cuboid articulations was performed as previously described for the plantar subluxed cuboid. Motion testing demonstrated a loss of the combined movements of dorsiflexion, abduction, and eversion, with decreased accessory plantar glide and conjunct medial rotation of the medial cuboid joint on the painful foot compared with the unaffected side.

There were no abnormal neurovascular findings, and roentgenographs demonstrated no bony abnormality.

Interpretation of clinical findings suggested a dorsal subluxation of his tarsal cuboid. After mobilization of the cuboid in the direction of joint restriction failed to restore joint motion, he was treated with manipulation of the cuboid in a plantar direction (Figure 7).

Manipulation for a Dorsal Subluxed Cuboid

The authors could not find a report of a dorsal subluxed tarsal cuboid or treatment method in the literature. The manipulation used in this case report is a two-person technique. The patient's foot is placed



FIGURE 7. Manipulation for a dorsal cuboid. The patient stabilizes the distal fibula and tibia (indicated by X). The therapist applies a longitudinal force through the fourth and fifth metatarsals (indicated by →). The other hand applies a plantar thrust through the dorsum of the cuboid (indicated by ↓).

on the bed in slight plantar flexion. Since distraction is integral to the technique, a second person is used to apply a distraction force. The second person places one hand anteriorly on the distal tibia to stabilize the calcaneus into the bed, while the other hand applies a longitudinal force through the fourth and fifth metatarsals. The therapist then delivers a plantar thrust through the dorsum of the cuboid (internal rotation of the patient's leg aligns the medial joint line more vertical). The technique can be done by one person if the patient grasps his or her lower leg to stabilize the calcaneus, and the therapist applies the longitudinal and plantar forces (Figure 7).

Following the manipulation, there was increased passive physiological mobility of the lateral functional unit in combined dorsiflexion, abduction, and eversion with increased plantar glide and conjunct medial rotation. Reassessment of the intertarsal and tarsometatarsal ligaments with a plantar and dorsal stress of the cuboid demonstrated increased dorsal movement compared with the unaffected foot, indicating ligament laxity. The lateral side of

his foot was iced for 10 minutes to reduce pain and swelling (13), and he was given instructions on partial weight bearing with crutches. Subsequent treatments consisted of passive physiological mobilization of the cuboid to restore normal joint nutrition and soft tissue mobility (12), ultrasound (19), strengthening and wobble board exercises (2,23). After five treatments, he was asymptomatic and discharged with a strength and proprioceptive training program to fully restore lower limb strength and coordination.

DISCUSSION

Inversion injuries commonly occur at the ankle. This mechanism of injury has been associated with subluxation of the tarsal cuboid. Since the mechanism of injury is common, it is possible that subluxation of the tarsal cuboid may occur more frequently than is recognized or reported.

The cuboid has strong ligamentous and osseous stability so the amount of trauma necessary to displace the cuboid usually causes an associated cuboid fracture

(4,6,11,14,16). Drummond and Hastings were the first to describe an isolated dislocation of the cuboid bone without fracture in a man who fell from a roof (7). Since that first case, others have reported dislocation of the cuboid without fracture (4,8,9,20) including three that occurred in association with an inversion stress at the ankle (8,9,20), and one that occurred as a consequence of compression trauma (4).

Inversion trauma or repetitive mechanical stresses to the joints and intertarsal ligaments about the cuboid have also been attributed to partial bony displacement of the cuboid (17,18,21,25). In 1981, Newell and Woodle (21) described the cu-

Patients with inversion sprains at the ankle or complaints of lateral foot pain should have the motion of their cuboid articulations assessed.

boid syndrome as a partial dislocation of the cuboid and a loss of its normal range of motion. Marshall and Marshall and Hamilton (17,18) described a similar condition with reduced motion of the cuboid and referred to it as subluxation of the cuboid.

Plantar displacements of the cuboid are most often reported in association with inversion and plantar flexion stress at the ankle (8,9,20). Fagel et al (8) concluded that the mechanism of injury resulting in an isolated dislocation of the cuboid was from rotation with associated inversion or eversion of the forefoot. The ligamentous disruption results in displacement of the cuboid. The peroneus longus tendon which travels in

the groove on the inferior surface of the cuboid exerts a dorsal and lateral force on the forefoot. This rotational force would close pack the cuboid in its articulations and force the bone in an inferomedial direction, tearing interosseous ligaments (7,9).

The authors postulate that an inversion stress at the ankle may cause a reflex contraction of the peroneus longus muscle in an attempt to restore balance and medial foot ground contact. A forceful contraction of the peroneus longus muscle creates a medial rotation of the cuboid (23). The peroneus longus tendon within the osseous fibrous tunnel on the inferior surface of the cuboid imparts a dorsal and lateral force on the cuboid, subluxing it inferomedially (Figure 8). Disruption of the intertarsal ligaments may occur from the inversion force or

when the cuboid is forcefully rotated.

To the present study's authors' knowledge, there has not been a reported case of isolated dorsal subluxation of the cuboid. Main and Jowett (16) reviewed 71 injuries of the midtarsal joint and found no instance of pure dorsal dislocation of the midtarsal joint. The study did, however, provide a description of the mechanics involved in some inversion and plantar flexion accidents at the ankle that may explain the mechanics of injury for a dorsal subluxed tarsal cuboid. Medial and longitudinal forces transmitted along the metatarsals compress the midtarsal bones between the hindfoot and metatarsals and push the forefoot medially. This can result in a midtarsal bone fracture with fragment displacement in a dorsal direction. Longitudinal forces associated with plantar flexion of the ankle can also cause disruption of the longitudinal arches with midtarsal bone displacement (16). The cuboid could be forced into external rotation with the medial side of the bone forced dorsally (Figure 9). If the plantar surface of the foot was blocked (ie., when the foot lands on an object) forces on the cuboid would be directed dorsally.

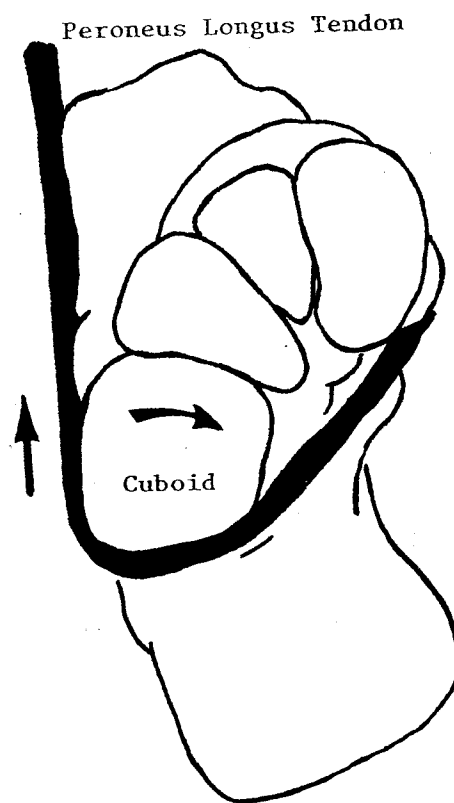


FIGURE 8. Anterior view of the right foot with a frontal section between the cuboid with the cuneiforms and the metatarsals (metatarsals removed). Location of peroneus longus tendon and its impartation of a dorsal and lateral force on the cuboid with forceful contraction.

SUMMARY

Full, active physiological and passive accessory joint motion is required for full pain-free range of motion. Restricted joint motion can cause pain and significantly impair joint function. Patients with inversion sprains at the ankle or complaints of lateral foot pain should have the motion of their cuboid articulations assessed. Appropriate assessment and treatment of subluxed tarsal cuboid can restore normal joint range of motion, alleviate pain, and improve function.

This paper has presented the manual techniques used to assess and treat subluxation of the tarsal cuboid. The characteristic patterns of

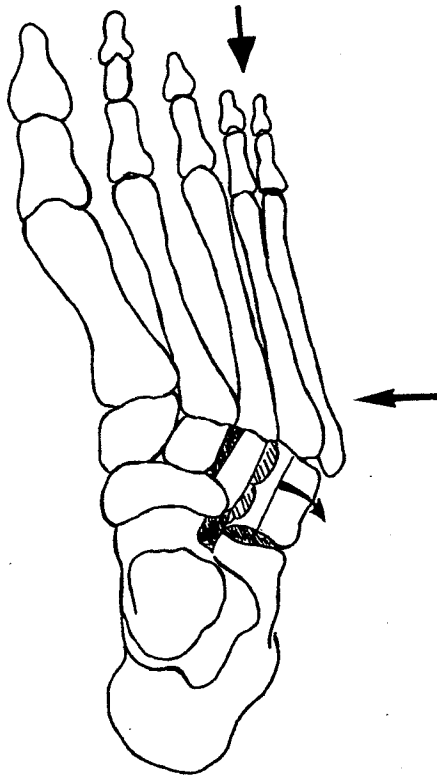


FIGURE 9. Mechanism of dorsal subluxation of the cuboid. The ↓ arrow and ← arrow indicate the direction of external force on the foot, while the → arrow indicates the resulting rotation of the cuboid.

motion restriction have been described to aid in the diagnosis of the direction of subluxation. Clinically, these tests appear to be effective. However, controlled studies will be necessary to validate their reliability.

JOSPT

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