

Cuboid subluxation in ballet dancers

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ABSTRACT

Cuboid subluxation is a common but poorly recognized condition. Its symptoms include lateral midfoot pain and an inability to "work through the foot." In addition, pressing on the plantar surface of the cuboid in a dorsal direction produces pain. The normal dorsal/plantar joint play is reduced or absent when compared to the uninjured side, and subtle forefoot valgus is present. Frequently, there is a shallow depression on the dorsal surface of the foot and palpable fullness on the plantar aspect of the cuboid. Documentation by radiograph, CT scan, or magnetic resonance imaging is difficult because of the normal variations found in the relationship between the cuboid and its surrounding structures. The diagnosis is primarily subjective, and must be made on the basis of the patient's history and physical findings. Treatment requires recognition of the condition, manual reduction by a therapist or physician familiar with the condition, and followup to be certain that the cuboid remains in place. Therapists and orthopaedists involved in the care of dancers should be alert to the possibility of cuboid subluxation and be able to recognize it when it occurs.

In spite of the scarcity of information in the medical literature on cuboid subluxation,⁸ experience with professional ballet dancers suggests that this is a common but poorly recognized affliction.⁹ We report the incidence of cuboid subluxation in American Ballet Theater, one of America's premier international ballet companies. The characteristic symptoms, physical findings, and theories regarding its cause are presented, as well as a variety of manual therapeutic techniques that reduce the subluxated cuboid and subluxation of the fourth metatarsal on the cuboid. When the physician is alert to this syndrome, it can be easily recognized. Patience and practice in manual reduction of the

cuboid will usually yield excellent and often dramatic results in the management of this commonly overlooked affliction.

A dancer (or athlete) with a cuboid subluxation will complain of lateral foot pain and weakness in push-off. The pain often radiates to the plantar aspect of the medial foot, the anterior ankle joint, or distally along the fourth ray. The dancer usually feels an inability to "work through the foot," while moving from foot-flat to demi-pointe or full pointe. Dancing vigorously and jumping are usually impossible because of localized, sharp pain. Pressing dorsalward on the plantar surface of the cuboid is painful. The cuboid's minimal dorsal/plantar joint play is markedly reduced or absent when compared to the uninvolved foot.

Severely subluxated cuboids sometimes leave a shallow, visible depression on the dorsum of the cuboid and a fullness on the plantar aspect. Unfortunately, repeated attempts to document or confirm 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. Other authors agree that this is probably caused by the minimal amount of subluxation that is present.^{2,6} Indeed, the term "locked cuboid," used by Hiss^{5,6} may more accurately describe this condition. This term suggests a small subluxation that markedly reduces the normal motion in the midtarsal (Chopart's) joint, altering the normal mechanics and the relationship between the hindfoot and forefoot. Other well-known and well-accepted conditions such as subluxations of the shoulder⁷ and metatarsophalangeal joints of the foot¹² cannot be documented on radiographs and the diagnosis must be made on the basis of the patient's history and physical examination.

Occasionally, the fourth metatarsal may subluxate on the cuboid. These subluxations can be easily mistaken for plantar subluxations of the cuboid, because the base of the fourth metatarsal almost always moves dorsally in the dancers we have seen. This diagnosis is aided by the fact that a subluxated metatarsal acts like a log floating in the water—when one end rises, the other end sinks. Thus, when the base of the fourth metatarsal subluxates dorsally on the cuboid, the head of the metatarsal will be plantarflexed ("dropped") when compared to the adjacent metatarsals and the fourth

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and the examiner standing at the patient's feet, and requires the clinician to "hang" the patient's lower extremity by grasping the fourth metatarsal, thus allowing gravity and the weight of the leg to help distract the cuboid-fourth metatarsal joint. This distraction is critical to the success of the technique and requires the complete relaxation of the patient's involved lower extremity. In cases where the cuboid is subluxated, the fourth metatarsal is then pulled in a longitudinal direction with the forefoot in slight plantarflexion (Fig. 4). Successful reductions are usually audible when performed in this manner.

Dorsal subluxations of the base of the fourth metatarsal are reduced similarly. The clinician uses the same hand placement as pictured in Figure 4. The fourth metatarsal-cuboid articulation is distracted by gravity as described previously. The final reduction force is produced with the second and third fingers by exerting a force in the plantar direction to the dorsal base of the fourth metatarsal, while simultaneously directing a dorsiflexion force with the thumbs to the plantar aspect of the head of the fourth metatarsal.

Although the techniques we have described will result in successful reductions at least 90% of the time, additional methods are needed in recalcitrant cases. One such method has the patient supine and the therapist standing at the foot of the table. The forefoot is maximally everted on a neutrally positioned rearfoot and maintained by the therapist's hand. The reduction force is delivered by the lateral aspect of the second metacarpal (Fig. 5). Frequently, the cuboid will reduce before the final pressure is delivered.

Successful reduction is usually, but not always, audible and, in cases treated within 24 hours of onset, it produces immediate and complete resolution of pain and dysfunction. Individuals who have had a cuboid subluxated for long



Figure 4. The examiner "hangs" the patient's injured foot by grasping the fourth metatarsal. Cuboids are reduced with a distraction force in the direction of the arrow.

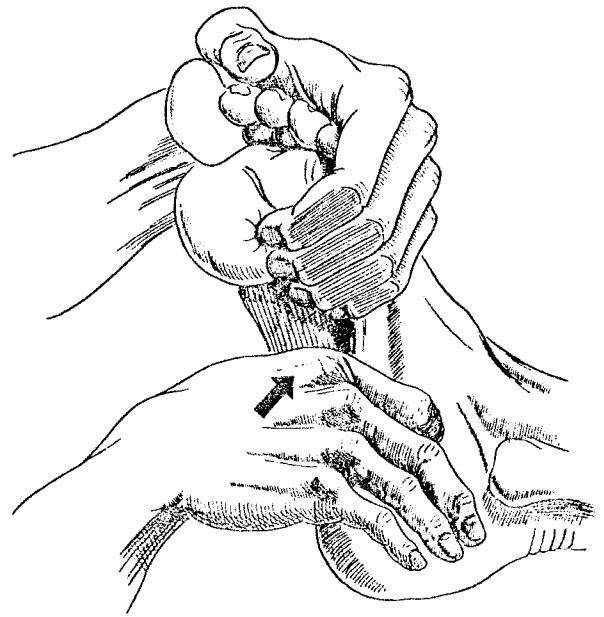


Figure 5. The clinician reduces the cuboid using the lateral aspect of his or her second metacarpal. The forefoot is maximally pronated on a neutrally positioned rearfoot before delivering a reduction force.

periods of time will experience a residual discomfort for several days after the reduction. This depends on the severity and duration of the subluxation, although the feeling of weakness should disappear immediately. Individuals who have chronic subluxations fall into two categories: those who frequently and easily subluxate and likewise reduce with ease, and those who subluxate with less frequency, but whose reductions can be taxing. The "easy" group will usually have complete resolution of symptoms after reduction, while the more difficult group may complain of an ache for a day or two. It is important to realize that despite the type of subluxation present and reduction method employed, there is *never* any doubt in the mind of the patient if a complete reduction has occurred. A partial cessation of symptoms signals a partial reduction, and complete reduction should be attempted.

Occasionally, attempts to reduce a subluxated cuboid will be unsuccessful. Repeated unsuccessful attempts are painful to the patient and should be avoided. In these cases, we recommend that the patient be treated with massage and ice and the reduction be attempted the following day.

Whenever possible, the dancer should refrain from vigorous activity for a day or two after reduction to avoid a recurrent subluxation. However, when a day of rest is not possible, a 1/8-inch felt pad is placed beneath the cuboid on the plantar aspect of the foot, and secured using the taping method shown in Figure 6. This is recommended to maintain the reduction. To repeat this method, a 1 1/2- to 2-inch elastic adhesive tape should be used and placed directly on the skin for maximum stabilization. The dancer is supine on a table with his/her foot off the table edge. Begin by applying tape

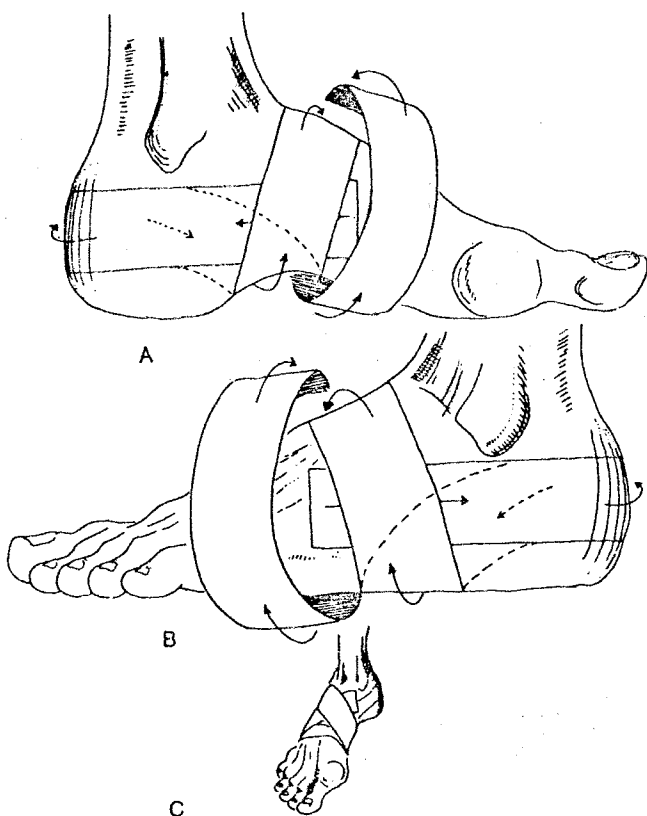


Figure 6. A minimal, three-piece taping method is used to maintain reduction of the cuboid subluxation. Begin taping from the medial aspect of the foot (A), and continue from the lateral aspect (B). The final step (C) secures the foot. (See text for details.) Reprinted with permission from Marshall P: The rehabilitation of overuse foot injuries in athletes and dancers. *Clin Sports Med* 7: 175-191, 1988.

to the medial aspect of the foot, starting proximal to the first metatarsal head (Fig. 6A). Place the tape around the heel and then continue to the plantar aspect of the medial longitudinal arch. Continue by encircling the rearfoot and midfoot twice. Figure 6B is similar, except that the tape is initiated from the lateral aspect of the foot. (For the sake of clarity, the previously applied tape is not shown.) Taping is secured with a final circumferential strip of tape (Fig. 6C), which should preferably be 3 inches in width. This taping also can be incorporated into a "J" strapping for greater control of the subtalar joint. Asking the dancer to relevé five or six times following a successful reduction will help determine whether the reduction will be maintained.

Cuboid subluxation following a second-degree or third-degree lateral foot sprain calls for special care to prevent a chronic condition from developing. If a cuboid subluxation is suspected after a lateral foot sprain, the therapist should refrain from attempting a reduction until the effusion and ecchymosis have significantly diminished and the possibility of fracture has been ruled out. This usually occurs in 3 to 7 days. A gentle reduction can then be attempted; however,

the cuboid squeeze is not recommended because the direction of the reduction force may cause further damage to traumatized tissues. Successful reduction should be maintained with felt and tape as described previously. A cuboid that subluxates recurrently may indicate that the joint capsule and ligaments have not healed adequately to maintain the reduction, and repeated reductions should be avoided. A minimum of 2 to 3 days before attempting another reduction is recommended.

The management of chronic subluxations should include instruction in self-mobilization techniques; otherwise, a dependency can develop between the dancer and the physical therapist. The most successful self-mobilization techniques are shown in Figure 7. These techniques are particularly successful in individuals who reduce easily when the cuboid squeeze is performed. Dancer and therapist should only reduce chronically subluxating cuboids when absolutely necessary, as further laxity may develop that only exacerbates the problem.

Acute lateral midfoot pain can be produced by conditions other than subluxation of the cuboid. Therefore, in cases where a cuboid subluxation is suspected but treatment is unsuccessful, other diagnoses should be considered:

- Unrecognized fracture or stress fracture.
- Acute tendinitis of the peroneus longus or the os peroneum.
- The sinus tarsi syndrome.^{1,10}
- Lateral process fracture of the talus.⁴
- Fracture or strain of the anterior process of the os calcis.³
- Derangement of the lateral talocrural and subtalar joints.
- The meniscoid of the ankle.¹³

Further diagnostic studies should be performed as indicated. If severe pain is present and the patient cannot bear weight, obviously the foot should be examined for acute fracture before manipulation is performed.

ILLUSTRATIVE CASES

Case 1

A 38-year-old male principal dancer made a choreographed exit from the stage during the first act of *Giselle*. As soon as the wings were cleared, he exhibited an antalgic gait and reported the sudden onset of left lateral foot pain after landing from a jump while slightly off balance. He complained of left foot "weakness" and feared that he could not continue to perform. He was scheduled to return on stage in less than 5 minutes. A brief examination revealed a marked loss of plantar/dorsal excursion of the cuboid and palpation of the plantar aspect of the cuboid was sharply painful. He was positioned supine and the manipulation shown in Figure 4 was performed. An audible reduction occurred and the dancer reported immediate cessation of pain and dysfunction with normal weightbearing and relevé. He returned to the stage as scheduled and performed without pain or discomfort. A felt pad and tape were applied at intermission to maintain the reduction. Five years after the incident, the dancer has not experienced another subluxation.



Figure 7. Self-mobilization techniques for cuboid subluxation. The dancer provides a reduction force via the cuboid squeeze (A) or by the base of a ballet barre (B).

Case 2

A 27-year-old female soloist sprained her lateral left foot while in the demi-pointe position. Marked pain and effusion followed and the dancer was sent for orthopaedic evaluation. Radiographs taken at that time were normal and the dancer received daily physical therapy. Four days later, sharp pain persisted about the lateral foot and a bone scan was performed to rule out bone abnormality. The scan was normal. Two days later, enough effusion and ecchymosis had resolved to allow further examination. At this time, a cuboid subluxation was suspected, and a gentle reduction of the cuboid was performed using the method shown in Figure 5.

The cuboid was reduced, but subluxated again three times: 5, 8, and 20 days after the original reduction. Each time the cuboid was reduced successfully using the same technique, and taping was used to stabilize the midfoot and hindfoot. Five years after initial injury, the dancer has not experienced any cuboid difficulties.

Case 3

A 23-year-old female soloist presented with complaints of lateral left foot pain that prevented her from rehearsing or performing regularly. There was no trauma associated with the gradual onset of this pain, which persisted for 2 years in spite of treatment with physical therapy, nonsteroidal antiinflammatory medications, and multiple cortisone injections. An extensive workup had been negative. Physical examination revealed a complete loss of normal dorsoplantar glide in the left cuboid bone. Slight abduction of the left midfoot and forefoot was present when compared to the opposite foot. Trophic changes were seen over the dorsum of the area secondary to the multiple cortisone injections.

The patient was treated daily with midtarsal joint adduction mobilizations (Fig. 2), along with rigorous attempts to return dorsoplantar motion to the cuboid. This motion was reestablished after 1 week and she was able to dance with less pain. The dancer was treated again 3 months later. During this period, marked improvement in cuboid mobility was achieved and several successful manipulations were performed (Fig. 5). The patient was instructed in self-mobilization (Fig. 7). Since that time, she has shown continued improvement, rarely experiences any significant cuboid-related discomfort, and has received several promotions in her ballet company.

CONCLUSIONS

Cuboid-related subluxations occur with consistent, significant frequency in high-level professional ballet dancers. With experience, the clinician can recognize and treat this syndrome. Management centers around the appropriate reduction and maintenance of the cuboid or fourth metatarsal. Technique factors predisposing an individual to subluxations should also be addressed to avoid recurrence. Lastly, clinicians should recognize that the techniques discussed in this article can be adapted to reduce subluxations of other tarsometatarsal articulations. Although much of our study is based on anecdotal evidence, the findings suggest a distinct clinical entity. Other conditions, such as subluxations of the glenohumeral joint and tarsometatarsal joints, are diagnoses that must be based on the history and physical examination alone. As the cuboid subluxation becomes better recognized and therapists are more aware of the problem, perhaps reliable methods of documentation or confirmation can be found.

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