

# THE ATHLETE WITH CEREBRAL PALSY

## CHALLENGES FOR THE TEAM PHYSICIAN

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The athlete with cerebral palsy (CP) presents a unique challenge to the sports physician. The complex interaction between primary neurologic impairment, secondary consequences of impairment, specific medical challenges and participation in elite sport (where the athlete performs at the maximal functional capacity) requires integrated management.

### ORIGINS AND CHARACTERISTICS OF CP

Cerebral palsy occurs with an incidence of 2.5 cases per 1000 live births and is the result of a non-progressive brain lesion, for example periventricular leukomalacia, stroke in utero, hypoxia during birth, trauma to the infant brain, etc. The condition can affect any area of the brain, with resultant cognitive, emotional, mental or movement dysfunctions. However, the most common barrier facing those individuals with CP wishing to compete in sport is movement

disorder, which often shapes athletes' preparation and participation in their chosen discipline.

Movement dysfunction as a result of CP is typically attributed to damage in one of three main areas, namely the motor cortex, cerebellum or basal ganglia. Damage to the motor cortex results in hypertonia, which is characterised by skeletal muscles with exaggerated levels of tension (spasticity) and reduced ability to stretch. Damage to the cerebellum results in ataxia, which is observed as a tremor and inability to control accurate movement. Furthermore, damage to the basal ganglia results in athetosis, which is characterised by involuntary slow and writhing movements. This is due to the basal ganglia's important role in modulating muscle activity in order to create smooth and specific muscle patterns<sup>1</sup>. A description of the types of CP and their aetiology is included in Table 1.

### PARTICIPATION IN SPORT AND CLASSIFICATION

Participation in sport and exercise for individuals with CP has grown steadily, both in the rehabilitation and sporting contexts, as can be seen by the growth of the Paralympic Movement. The development from social exerciser to elite athlete is much like that of an able-bodied athlete, but with special considerations with respect to the athlete's impairment and specific functional and medical challenges that face those with CP and the team that support them.

Sport-specific classification is required for all para athletes in order to ensure fair competition at the national or international level. Within the classification system as outlined in the 2015 IPC Classification Code, impairments are grouped into the following categories: impaired muscle power, impaired passive range of movement, limb deficiency, short stature, hypertonia,

**TABLE 1**

Type	Etiology
<i>Spastic type (75% of all cases)</i>	
<i>Hemiplegic</i>	<i>Focal perinatal injury (most commonly middle cerebral artery)</i> <i>Infarction in a vascular distribution (ischemic brain necrosis)</i>
<i>Diplegic</i>	<i>Ischemia (periventricular leukomalacia)</i>
<i>Quadriplegic</i>	<i>Major hypoxic event (perinatal asphyxia)</i> <i>Trauma (parasagittal cerebral injury)</i>
<i>Dyskinetic and Mixed types (25% of all cases)</i>	
<i>Dyskinetic</i>	<i>Kernicterus (bilirubin deposition in the basal ganglia)</i> <i>Diffuse anoxia (hypoxia of basal ganglia and thalamus)</i>
<i>Mixed</i>	<i>Mixed</i>

**Table 1:** Presents a basic description of the types and etiology of different types of cerebral palsy.

ataxia, athetosis, visual impairment and intellectual impairment. Each sport has its own classification scheme, inclusive of sport-specific impairment testing and class allotment. The classification process for athletes with CP includes assessment of neuromuscular function both in the clinical and sporting setting. Athletes with CP are classified according to deficits observed within the classification categories of hypertonia, ataxia or athetosis.

**SPECIFIC MEDICAL CHALLENGES OF THE ATHLETE WITH CEREBRAL PALSY**

There are several medical challenges that face sports physicians managing athletes with CP and indeed all athletes with impairment. The following are some of the most important factors to consider when managing this group of athletes. It is important, however, to note that every athlete with CP will require his or her own patient-centred management strategy for a specific set of impairments.

**High risk of musculoskeletal injury**

Athletes with CP are more susceptible to injury in both upper and lower limb distributions. Spasticity is often a causative factor in these injuries, as a spastic muscle has increased tone during movement and rest but has limited ability to stretch, resulting in deficiencies in range of motion of the affected joints. This dysfunctional muscle activity results in abnormal loads being placed on certain areas of the athlete's body, predisposing the anatomical area involved to injury. For example, a spastic hamstring muscle will contribute to abnormal loads being placed on the knee and hip joints. In response to this increased load, the surrounding muscles which are not affected by spasticity will compensate for the dysfunctional hamstring activity. This will lead to increased load as a result of these compensation strategies in other areas of the body, for example the lower back, predisposing the athlete to injury in any of these areas<sup>2</sup>.

Patellofemoral pain syndrome is a condition seen in athletes with CP, due

to quadriceps muscle spasticity. Older athletes are also at higher risk than younger athletes<sup>3</sup>. As discussed above, an abnormally high load is placed on the patella and surrounding structures due to quadriceps muscle spasticity, resulting in maltracking patterns of the patella in the trochlear groove, with resultant retropatellar cartilaginous damage. The muscle spasticity also prevents the knee from executing well-planned movement strategies due to the constant forces (and incorrect muscle activity patterns) exerted on the joint.

It is important that team physicians evaluate their athletes with CP both at rest

and during movement, so that these above-mentioned factors can be appreciated. Athletes should also be assessed once fatigue has occurred, as abnormal gait patterns might be exaggerated. These factors must be taken into consideration when assessing the athlete with chronic overuse injuries and should be addressed in patient-centred sports rehabilitation programmes. This should focus on biomechanical correction as well as strengthening weak or disused muscles and flexibility training for joints affected by spasticity in an attempt to increase range of motion.



**Image 1:** By Wil Punt.



Image 2: By Wil Punt.

#### *Spasms following maximal exertion*

The effects of an acute spastic reaction can be observed during competition when the athlete, usually toward the end of an event, develops severe spasticity in all affected areas. This usually requires medical intervention, when the athlete falls or has to be withdrawn from the event due to whole body spastic reaction. This condition is typically self-limiting and spasticity recedes over time, however should the athlete be uncomfortable or the spasms prolonged, pharmacological anti-spasmodic agents or muscle relaxants may be required. Examples include use of medications such as tizanidine, baclofen or diazepam, or injection-based therapy with use of nerve blocks, phenol or Botox injections. Particularly, physicians should be aware that skin abrasions and lacerations might require attention if the athlete fell during the spasm.

#### *Ankle and foot deformities*

Ankle and foot deformities are common in athletes with CP. Ankle equinus is defined as limited of ankle dorsiflexion (typically less than 10 degrees movement) resulting in limited ability of the toe to clear the floor during the swing phase of the gait

cycle. Foot equinus is defined as permanent plantar flexion which results in only the forefoot being able to bear weight. These two equinus deformities often result in alteration of walking and running biomechanics. Ankle equinovarus (also known as club foot) refers to the internal rotation of the foot at the ankle joint and if not surgically treated, results in athletes who can be observed walking on the lateral border of their foot. Valgus deformities combine an equinus deformity of the hindfoot and pronation deformity of the mid and forefoot. This deformity presents as athletes who walk on the medial border of their feet, with resultant instability during the push off phase of the gait cycle<sup>4</sup>. Athletes with these deformities of the lower limb are at an increased risk of foot conditions causing pain (e.g. metatarsalgia), ankle instability and a higher frequency of calluses and pressure sores on the high-load-bearing aspects of the foot. The inclusion of a podiatrist in the medical support structure of the high performing athlete with CP should be an important consideration, as orthotic or bracing provisions to address these abnormalities form an important aspect of patient-centred management. In severe cases, timely referral

to an orthopaedic surgeon to offer surgical intervention is required.

#### *Pain*

Pain is one of the most commonly reported challenges facing physicians who manage athletes with CP. Leg, hip and lower back pain are the most common sites affected and pain can occur in up to 80% of individuals with CP. In CP, the pain is thought to be related to increased muscle tone, dystonia and spasticity. Sometimes pain can go unmanaged for long periods of time, particularly if pain is erroneously considered to be part of the diagnosis of CP itself or if there are communication impairments such as dysarthria or cognitive impairments. It has also been shown that pain is not well managed and persists over long periods of time<sup>5</sup>. Common agents used in the management of pain in athletes with CP include paracetamol, non-steroidal anti-inflammatory drugs, codeine and other opiates (for more severe pain). If the use of opiates is required, a Therapeutic Use Exemption is mandatory for competition. In rare cases, severe pain that is refractory to conservative measures may be managed with the help of a spinal cord stimulator or implantable morphine pump.



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Pain that is attributable to spasticity can be managed by anti-spasmodics, such as outlined above. Non-pharmacological methods of pain management include physical therapy (stretching, massage, splinting, ice, ultrasound, transcutaneous electrical nerve stimulation and biofeedback). On rare occasions, operative interventions including selective dorsal rhizotomy, tendon release or other surgical procedures may be required.

#### ***Fatigue***

Fatigue is defined as a reduced capacity to sustain power output over time and experienced by the athlete as feeling tired, weak or lacking energy. Fatigue, along with pain, is a very common symptom associated with CP. It may be associated with dysfunction of the neurological system and have complex origins, encompassing both physical and psychological components. Fatigue in those with CP has been thought to occur due to lower efficiency of movement and therefore higher energy costs, leading to increased tiredness. The clinician, however, needs to make a distinction between pathological fatigue and physiological fatigue. Physiological fatigue is considered an expected response to a stimulus including training and is rapidly reversed upon the withdrawal of the stimulus. Pathological fatigue can result from disease or disorders of the various physiological systems and should be managed according to the specific diagnosis. Team physicians should

be encouraged to include a full athlete work up including blood investigations and other special investigations, to exclude organic causes of the presenting fatigue.

#### ***Degenerative arthritis***

Due to the abnormal loads placed on the bones and joints of athletes with CP and the predisposition to injury due to spasticity and contracture, as described above, these individuals often develop osteoarthritis at an earlier age than their able-bodied counterparts<sup>6</sup>. Indeed, athletes with CP are also at higher risk for developing degenerative joint disease, as decreased muscle activation reduces the protective action of surrounding muscles to susceptible joints. These joints, including the lumbar spine, hip, knee and ankle/foot complex, are at higher risk for injury and resultant degeneration. This load is compounded by the athletic training undertaken by athletes with CP, which inherently increases these risks through the high mechanical loads generated. Sports physicians and rehabilitation specialists should also be aware of the phenomenon of overloading of the sound (non-affected) side in hemiplegic athletes with CP, as movement is often compensated for by the more functional side with resultant increased loads.

#### ***Oral health***

Oral health commonly requires regular management in this group of athletes, due to altered growth patterns that result

in bone and oral-motor malformation and dysfunction. This dysfunction often leads to increased risk for cavities and gum diseases. Athletes with CP should be regularly seen by their dentist and educated with respect to their own specific oral health needs. Furthermore, drooling is common in athletes with damage to areas of the brain that effect oral motor control. Drooling is seen with higher frequency in children and more severely affected individuals, often where spasticity has impaired correct movement in the masseter muscle. Drooling is often associated with speech impediments in this group, both as a causative and resultant factor. Despite the common misunderstanding that speech impediments are associated with intellectual impairment, a study which examined this relationship reported no such association between the two variables<sup>7</sup>.

#### ***Vision and hearing impairments***

Vision and hearing impairments are seen in a significant percentage of individuals with CP (vision impairment: 25 to 39%; hearing impairment: 8 to 18%). In these athletes, hearing or vision impairment is an additional impairment that must be considered in addition to the more commonly seen motor impairment. The athlete with CP and vision impairment will have to adapt his or her life in the same manner as visually impaired athletes. These concomitant impairments, which are seen fairly regularly in Paralympic athletes, have

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the potential to have a negative impact on the quality of life and psyche of the athlete.

#### *Higher than average comorbidities*

Individuals with CP have a higher incidence of chronic diseases than the general population. Due to developmental anomalies including organ malformation, there is a higher incidence of hypertension and genitourinary dysfunction in the adult population with CP. Increased risk for fractures as a result of low bone mineral density is also often said to be a challenge for non-ambulatory athletes with CP. However, the only study investigating bone mineral density in high performing athletes with CP showed no difference to the values published in a normative database<sup>8</sup>.

#### *The athlete with high support needs*

The athlete with high support needs incorporates those athletes who have severe CP, usually affecting all four limbs and require wheelchairs or other devices to ambulate. The challenges facing these athletes are similar to those facing athletes with less severe forms of CP, however at an increased intensity and frequency. Furthermore, the use of a wheelchair or motorised devices, requiring sitting for extended periods of time, presents a its own

set of challenges. These include the potential for pressure ulceration, neural entrapments, skin and subcutaneous tissue degeneration (with resultant infection) and an increase in axial musculoskeletal conditions causing lower back pain associated with increased sitting and poor posture. The athlete with this level of needs often requires full-time personal care assistance and frequent interventions by his or her medical team.

#### *Depression and resilience*

The psychological load of physical impairment on well-being has been established. Indeed, athletes are often required to cope with their primary impairment, secondary degenerative changes, additional impairments or injuries as well as the demands of participating in elite sport. Furthermore, social anxiety and negative experiences are common in the physically impaired population. Each individual will be equipped with his or her own coping mechanisms. In this context, it is the physician's responsibility to ensure that each athlete is being managed in all aspects of well-being and health, not only those aspects that fall within the medical field. Appropriate assessment and referral to psychiatric and psychological support systems, particularly in the elite sport

setting, is deemed as an important adjuvant to the multidisciplinary support team.

There seems to be, however, a pattern of resilience to adversity in the Paralympic population. These athletes are characterised by their ability to triumph over the physical impairments mentioned above, as well as maintain their positive attitude toward their lives in general. For example, it has recently been postulated that this resilience is a factor differentiating Paralympic athletes' physiological response to competition in the heat from their able-bodied counterparts. However, the physician should be aware that athletes can be experiencing stress or pain that they might be able to suppress, yet has the possibility of negatively impacting athlete health and performance, thus requiring additional professional help<sup>9</sup>.

#### THE IMPORTANCE OF PHYSICAL THERAPY AND PHYSICAL ACTIVITY IN ALL INDIVIDUALS WITH CP

Although there are specific medical challenges associated with CP, there are several secondary conditions that may be avoidable. Recent studies conducted on athletes with CP have shown that the secondary degenerative effects of physical inactivity may be circumvented in this population through participation in exercise from a young age. It is important that physicians are encouraged to refer children with CP to appropriate exercise programmes. However, when one evaluates the higher risk for both these secondary changes (post-impairment syndrome) as well as chronic diseases (comorbidities) in this population, it is even more important to maintain lifelong exercise participation<sup>10</sup>. Engagement in physical activity from childhood should be a primary goal of physicians and the medical support team managing this group of unique patients.

#### CONCLUSION

The athlete with CP requires complex management in a patient-centred, multidisciplinary setting. This article has highlighted some of the physiological challenges facing sports physicians who manage these athletes, as well as specific medical concerns that require unique management in this population.



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