THE ATHLETE WITH VISUAL IMPAIRMENT

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AETIOLOGY

Visual impairment (VI) is caused by impairments to the ocular globe, optical nerve or visual cortex, resulting in a functional limitation in the interaction of the person with the environment. This impairment can be divided into blindness and low vision, according to the degree of remaining vision. Blindness encompasses the spectrum from complete vision loss to the perception of light and colour, but in a non-functional condition for motor learning. Low vision is defined as the ability to perceive light, colour and form, but has limitations in the perception of space, details, movement, three-dimensional and compound shapes[1].

It should be noted, of course, that there are notable discrepancies between the prevalence of various aetiologies of visual impairment in the general population versus para athletes. This difference is due mainly to the mean age of competing athletes as well as world regions for which para sport is highly developed. Socioeconomic development, the availability of primary healthcare and eye care services highly determine the frequency with which these pathologies are recognised according to each region[2].

PARALYMPIC SPORTS

The history of sport participation by persons with VI dates back to the beginning of 20th century in athletics events, baseball and gymnastics taking place in the United States[3]. Today, athletes with VI compete in the summer Paralympic sports of athletics, cycling, equestrian, football 5-a-side, goalball, judo, rowing, swimming and triathlon, as well as the winter sports of alpine skiing, biathlon and cross country skiing[4]. Athletes with VI are divided into three sporting classes. The minimal disability criteria to be eligible for participation in para sport is based on the American definition of legal blindness (visual acuity in 20/200)[5].

The current classification system is based on factors related to both visual acuity and visual field (Table 2). While this classification system is based on biomedical concepts only, there is a great demand for adjustments to be made so that there is an evaluation of the visual functionality applied to each sport[7].

Unique characteristics of the Paralympic classification system for athletes with VI are noted in Table 3. Indeed, each Paralympic sport varies with regard to type of support offered to athletes with VI. In some sports the athletes compete only in their sport class and, in others, they compete in a single class (all classes together). Additionally, in some

Table 1

	Main Etiology	Characteristics	Relevance to para athletes
1	*Cataract*	*Accounts of 51% of blindness globally (2010)*	*Very commonly found among para athletes*
2	*Onchocerciasis (river blindness)*	*Seen most frequently in the African region*	*As para sport in Africa continues to increase it may be seen more frequently*
3	*Childhood blindness*	*Etiologies include vitamin A deficiency, rubella, cataract, retinopathy of prematurity, congenital abnormalities*	*Very common*
4	*Refractive errors and low vision*	*Etiologies include myopia, hyperopia with or without astigmatism*	*Many of those affected are not eligible in VI functional classification*
5	*Diabetic retinopathy*	*Noted in individuals with chronic diabetes mellitus*	*Very uncommon*
6	*Glaucoma*	*Group of diseases with optic neuropathy as a common endpoint*	*High ocular pressure demands special medical attention in sport*
7	*Age-related macular degeneration*	*Condition affecting older individuals*	*Very uncommon*
8	*Corneal opacities*	*Encompasses wide variety of infectious and inflammatory eye diseases that scar the cornea*	*Very commonly seen in para athletes, due to many different and often uncommon eye diseases*
9	*Genetic eye diseases*	*Ocular pathologies transmitted from parents to children by genetic inheritance*	*Since athletic performance also has a hereditary component, it is not unusual to find in para athletes' siblings*

Table 1: Most common etiologies of visual impairment globaly[2].

sports, blindfolds are utilised to completely obscure the vision (and ensure equal level of impairment) for all athletes, such as the B1 class, or for all athletes during competitions with combined classes.

Finally, some sports allow for an escort-athlete such as a guide or pilot to assist the athlete with VI. The function of the guide or pilot is to support the athlete in their limitation – visual orientation of the environment. For example, in the sport of athletics, the role of the guide is to run together with the athlete at the same pace, read the environment and translate this to the athlete with verbal and tactile cues.

Table 2

Impairment	Class	Range of Visual Function
Blindness	*B1*	*Visual acuity poorer than LogMAR 2.6.*
Low Vision	*B2*	*Visual acuity ranging from LogMAR 1.5 to 2.6 (inclusive) and/or visual field constricted to a diameter of less than 10 degrees.*
Low Vision	*B3*	*Visual acuity ranging from LogMAR 1.4 to 1.0 (inclusive) and/or visual field constricted to a diameter of less than 40 degrees.*

Table 2: Classification based on visual impairment in Paralympic Sports[6].

CLINICAL MANAGEMENT

There are several points that are important to keep in mind when providing clinical care for athletes with VI. Among the challenges facing the medical staff are two basic principles of clinical practice: empathy and communication. Nonverbal cues play an important role in physician-patient interactions, and often these rely on visual information[8,9]. VI athletes are often not able to pick up visual cues from medical staff. And for those with onset of the impairment early in life, who have not learned the socially accepted facial expressions associated with each emotion or with what one may want to infer, may it be through a smile of comprehension or a frown denoting doubt on what is being said. For this reason, when interacting with athletes with VI, one must pay special attention to voice intonation, both when speaking and when listening, as well as one's direction when speaking. For example, not speaking directly at the athlete (as when looking at a computer screen and asking questions at the same time) might be interpreted as lack of attention. Touch can be used as a tool to better communicate, as it denotes interest and may be used to anatomically explain an injury or better define where a pain is felt (always previously explaining where one is going to touch and having asked permission to do so[10]).

Persons with blindness, particularly in congenital or early onset, may manifest mannerisms[15]. These are repetitive

behaviours or movements that do not appear to be directed towards obtaining a goal, for example, eye manipulation, body rocking or flicking fingers in front of the eyes while staring at light. These are more frequent when the person with blindness is experiencing stress or anxiety.

As with all Paralympic sports, the physician must consider anti-doping regulations at all times, including which substances and methods are included on the World Anti-Doping Agency (WADA) Prohibited List, as well as the impact of all prescribed substances on sports performance. Specific to athletes with VI, providers must take care with use of acetazolamide and beta-blocker eye drops, often prescribed for glaucoma, both of which are prohibited substances. Insulin, often prescribed for glycaemic control in individuals with diabetes mellitus and diabetic retinopathy, is also a prohibited substance. Each case must be considered individually to determine whether such medications are ideal for treatment of the disease process, while also taking into consideration athlete performance.

The understanding of the VI mechanism is fundamental as some types of exercises by persons with specific impairments, without adjustments to the training protocol or environment, may worsen the impairment. For example, contact sports such as goalball and judo should not be recommended for those at risk for retinal detachment[11]. If contact sports are pursued by at-risk individuals, head protection should be used. In some more severe cases, jump training can induce retinal detachment. Precautions should also be taken for athletes with diabetic retinopathy as heavy weightlifting dramatically increases blood pressure and may cause retinal bleeding[12,13]. Athletes with glaucoma require special attention during intense physical exercise, as changes in body position and increased respiratory volumes, especially with Valsalva manoeuvre, may place the athlete at risk[14]. Finally, it is important to note that the reduced visual stimulus on the visual cortex may trigger what is known as Claude Bonnet syndrome, which can cause visual hallucinations, most commonly in the image of a person, and affects between 0.4 and 14% of people who lose their vision during their lifetime[16,17]. It is a condition analogous to the "phantom limb syndrome"[16]. The traditional treatment approach is pharmacological intervention[16].

Table 3

	Classes	Escort/Support*		Blindfold	Combine
Athletics	*11/12/13*	*Guide*	*11/12*	*11*	
Cycling	*11/12/13*	*Pilot*	*All*		*X*
Equestrian	*B1/B2*	*Caller*	*B1/B2*		
Football 5-a-side	*B1*	*Goalkeeper*		*B1*	
Goalball	*B1/B2/B3*			*All*	*X*
Judo	*B1/B2/B3*				
Rowing	*B1/B2/B3*			*All*	*X*
Swimming	*11/12/13*	*Tapper*	*11/12*	*11*	
Triathlon	*11/12/13*	*Guide/Pilot*	*All*	*11*	*X*
Alpine Skiing	*B1/B2/B3*	*Guide*	*B1/B2/B3*	*B1*	*X*
Biathlon	*B1/B2/B3*	*Guide*	*B1/B2/B3*	*B1*	*X*
Cross Country Skiing	*B1/B2/B3*	*Guide*	*B1/B2/B3*	*B1*	*X*

** Support is mandatory for athletes in Class B1 or 11 however is an option for athletes in class B2 or 12.*

Table 3: Characteristics of competition across Paralympic sports and classes for athletes with VI. Class 11 is equivalent to B1, class 12 to B2 and class 13 to B3. Adapted from IPC 4.

Another important point to note is that athletes with no light perception (full blindness) may experience a disruption in their circadian rhythms[18]. This has the potential to result in:

- Reduced peak performance, simple reaction time and body temperature regulation throughout the day[19].
- Altered concentration and distribution of melatonin throughout the day[18].
- A delay in the prepubertal growth period, especially in women[20].
- Later menarche in women[21].
- Sleep disorders[22].

Furthermore, it is a challenge for B1 and B2 athletes to self-monitor hydration from the standpoint of urine colour and volume[23]. Although an imperfect measure, some athletes use the smell of the urine as a guide, since a stronger smell of urine is usually associated with a higher concentration.

All of the above conditions can impact the performance, training and recovery of the athlete with VI. They also play a major role when travelling to different time zones for competition. Adjustments are necessary to minimise the effects on training quality and performance.

THE IMPACT OF VISUAL IMPAIRMENT ON PHYSICAL CAPACITY

Inherently, the presence of VI modifies the quantity of visual information received and limits one's perception of environment. However, this is not only due to lack of visual information, but also due to limited exposure to incidental information over time[24]. Compensatory strategies are necessary to minimise resultant limitations in motor control and the spatial orientation.

Visual impairment interferes in a significant way on the accomplishment of specific aspects of performance in non-trained individuals, which differs from the pattern seen in trained athletes[25]. With

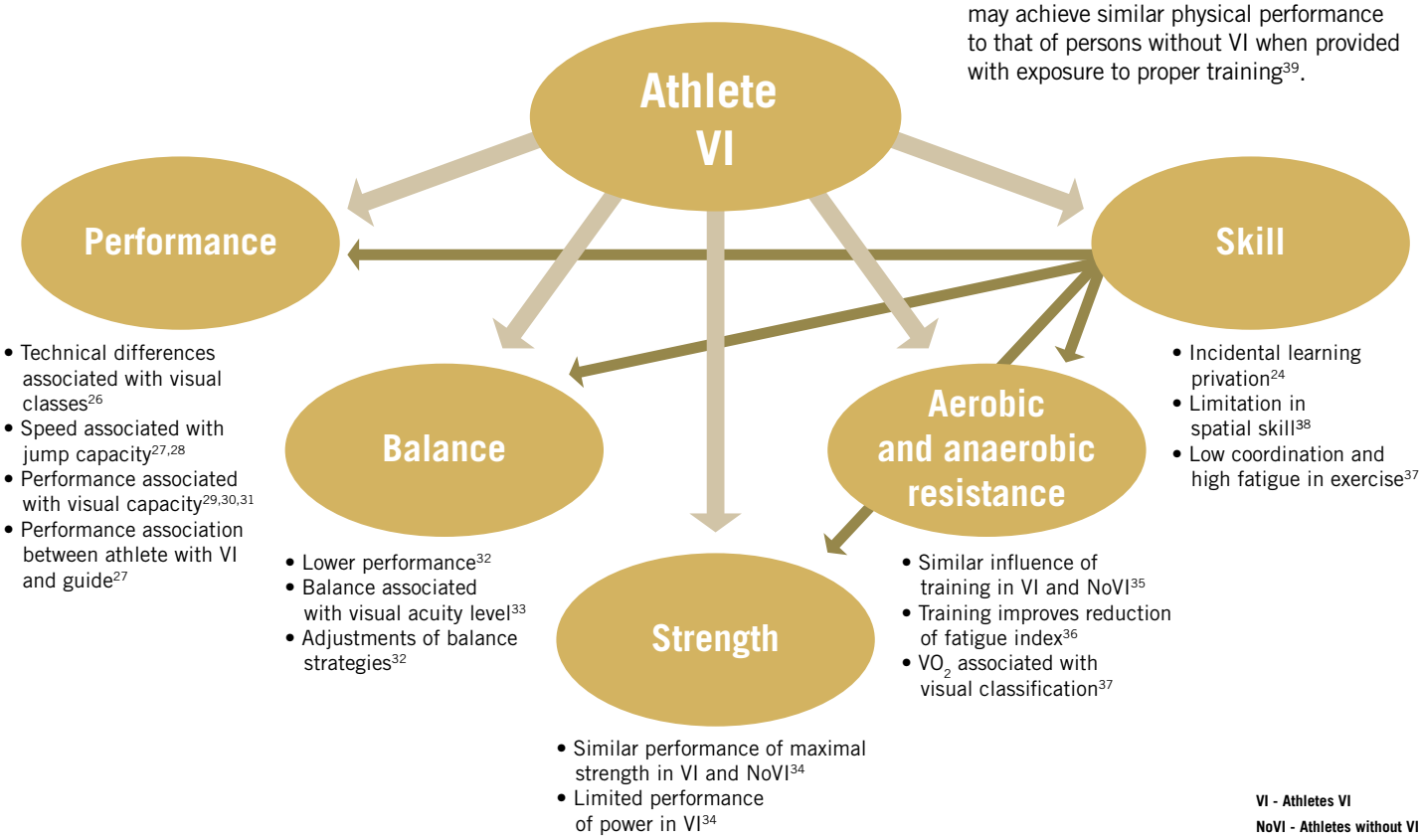

Figure 1: The Impact of Visual Impairment on Physical Capacity.
It is important to note that persons with VI may achieve similar physical performance to that of persons without VI when provided with exposure to proper training[39].

this notion as a starting point, Figure 1 provides a summary of the pattern of motor responses observed in athletes with VI and how it is related to the development of physical abilities in this population.

INJURY EPIDEMIOLOGY

Recent evidence demonstrate higher injury rates in athletes with VI that compete in summer sports. At the 2012 Summer Paralympics Games the highest injury incidence rates was found in football 5-a-side, followed by powerlifting, goalball, wheelchair fencing, wheelchair rugby, athletics and judo[1]. Of the seven sports with the highest injury incidence rate, three were practiced exclusively by athletes with VI and a fourth (athletics) is inclusive of all three VI classes.

In general, injuries to the lower limb, followed by the upper limb, were more frequent in athletes with VI[40,41]. Acute traumatic injuries were particularly prevalent in football 5-a-side[41,42]. This may be related to the VI, making athletes more vulnerable to bump into other players (with lack of a protective reflex), barriers in the training and competition area or objects on the field[41]. The same rationale explains the higher incidence of lesions of the feet and legs that occur during daily activities in VI athletes, not directly related to sports[23]. Additional evidence reveals that the greater the VI, the higher the prevalence of injury in an athlete population[43]. This can be related to the fact that postural stability is affected by vision and proprioception in blind individuals tends to be worse than in those with partial vision resulting in abnormal gait and biomechanics, which can lead to injuries[43].

CONCLUSION AND PRACTICAL APPLICATIONS

Although the presence of VI may impact the performance of the athlete, sport-specific training and excellence in sports medicine services may be helpful in mitigating any detrimental effects. This process is guided by knowledge regarding the aetiology of VI as well as its consequences on short- and long-term performance. From a practical standpoint, it is fundamental in this process to provide excellent spatial orientation, adequate stimulation and an efficient channel of communication with sports medicine providers.

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