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Review Article

Sickle Cell Disease Findings Oftalmologicos that may Contraindicate Use of Hyperbaric Treatment in Monoplace Camera

Leticia de Avila Franco*

Ophthalmologist, University of Cuiabá, MT, Brazil

***Corresponding Author:** Leticia de Avila Franco, Ophthalmologist, University of Cuiabá, MT, Brazil.

Received: February 20, 2017; **Published:** March 16, 2017

Abstract

Hyperbaric oxygen therapy (HBO) is a treatment modality consisting of oxygen inhalation, pure (100% O_2) at ambient pressure above atmospheric pressure measured at sea level.

Treatments are performed with patients inhaling pure oxygen housed within chambers, pressurized with air (multi-chamber chambers), or with oxygen (monoplace chambers), at a pressure superior to an atmosphere.

Keywords: *Sickle Cell; Monoplace; Hyperbaric oxygen therapy*

There are four main effects of HBO:

Proliferation of fibroblasts- HBO, through the increase of dissolved oxygen in liquids allows the arrival of adequate concentrations of oxygen in vascularization favoring the healing of problematic wounds.

Neovascularization- During HBOT sessions, tissues receive greater amounts of oxygen than normal. Immediately after the session the body tissues are submitted to hypoxia (Return to normal oxygen concentration), which is responsible for the stimulation of Neovascularization.

Osteoclastic and Osteoblastic activity- aOHB, through the increase of oxygen dissolved in the tissues, allows the arrival of adequate concentrations of oxygen in the bones, allowing the osteoclastic and osteoblastic activities, thus being indicated in the adjuvant treatment of chronic osteomyelitis.

Antimicrobial action- Oxygen tension plays a critical role in the development of Infections. Various pathological conditions, such as lesions or infections, may oxygen tension at the affected site, where fluid from experimental lesions often presents values less than 10 mmHg. In Experimental bone infections, there are reductions of 50% of the stresses.

Therefore, conditions of considerable hypoxia or even anaerobiosis are found in tissues of organisms, favoring the growth of specific bacteria.

At the outset, it is in these infections that hyperbaric hypoxia presents greater therapeutic potential.

Several antibiotic mechanisms were identified in the direct action of hyperoxia on bacteria in molecular biology studies of microorganisms, such as (3): -

"Inhibition of amino acid biosynthesis - HBO blocks dihydroxy acid dehydratase, favoring proteolysis and blocking bacterial growth;

Inhibition of membrane transport - oxidation of transport proteins containing the sulfhydryl groups, typical effect of the superoxide anion, also compromises the uptake of substrates and;

Inhibition of DNA synthesis and degradation - direct lesions to RNA and DNA of the bacteria are induced.

Activated oxygen radicals- Favoring the microbicidal and microbiostatic action Oxygen, forming free radicals inhibiting bacterial metabolism "Radical free - oxygen upon entering organisms, turns into free radical called Superoxide (O_2^+ - O_2^-), it can be inhibited by superoxide dismutase (SOD) (O_2^- + O_2^- + H! SOD! H_2O_2 + O_2).

Oxygen therapy increases SOD and slows down radicals. Therefore, HBO increases the free radicals and stimulates the formation of organic defenses through the production of Superoxide dismutase (SOD), resulting in an improvement of the oxidative load of the organism, decreasing cell aging.

In this current work, we will show the pathophysiology of sickle cell disease as the lesion Ischemia - state of hypoxia of the tissues, the main cause of the forms of disease.

Sickle cell disease - correlating the treatment of ischemic syndromes with HBOT.

Sickle cell disease (DF) is a generic term used to define a group of genetic alterations characterized by the predominance of hemoglobin S (HbS). Which encompasses a group of hereditary hemolytic anemias characterized by the structural alteration in the beta-globin chair leading to the production of an abnormal hemoglobin called HbS (derived from the English sickle), hence the name sickle cell disease [1,2].

FD is a frequent genetic disease in humans, being also very prevalent in Brazil [3].

According to the type of alteration present in hemoglobin, this hemoglobinopathy can be classified into distinct clinical forms: homozygous form SS, which is sickle cell anemia (HbSS), and heterozygous forms, represented by associations of HbS with other variants of hemoglobins, Such as: HbC, HbD and the interactions with thalassemias (α, β0 and β +) [4].

Sickle cells have a very short survival time, from 16 to 20 days, when compared to 120 days of normal erythrocyte [4,5]. In the presence of low oxygen tension, HbS is the result of the exchange of glutamic acid by valine at position 6 of the beta chain of hemoglobin. Polymerization of this hemoglobin is the primary determinant of disease severity; however, there are other factors that contribute to the pathophysiology of the disease, such as changes in the structure and function of the red cell membrane, disorders in cell volume control and increased adherence to the hemoglobin. Vascular endothelium, Sickle cell disease, in addition to chronic anemia, is characterized by numerous complications that can affect almost all organs and systems, with significant morbidity, reduced work capacity and life expectancy.

Sickle cell disease (DF) is a common genetic disorder. It predominates among blacks and mulattos, and in Brazil, every year, 3,500 children are born with DF and 200,000 with a sickle cell trait. The red blood cells with hemoglobin S assume, in conditions of hypoxia, a form similar to the sickle, which can lead to occlusion of the capillaries, causing acute and chronic tissue lesions of organs, almost always accompanied by pain.

In Brazil, the disease is heterogenous in the population and is more prevalent in regions with higher afro-descendent populations. In southeastern Brazil, the average prevalence of heterozygotes (carriers) is 2%. However, it is noted that this figure rises to about 6 - 10%

among Afro-descendants. Based on this prevalence, it is estimated the existence of more than 7 million HbS gene carriers in Brazil and more than 3,500 individuals with the homozygous form of the disease (HbSS). Thus, sickle-cell diseases are characterized as a public health problem in Brazil, considering the estimated new annual cases of the disease in the country.

Hemoglobin S for hemoglobin S (sickle cell trait) defines a relatively common but clinically benign condition. The vast majority do not present adverse clinical consequences, except for some reports of changes at high altitudes (above 3200 meters and on flights with depressurized cabin). From the hematological point of view, global counts and erythrocyte morphology.

The survival of red blood cells shown to be normal. Therefore, individuals do not present with anemia or hemolysis and their clinical follow-up should be performed in the same way as the AA (normal) Hb population, since they will frequently be exposed to the same medical problems.

The Neonatal Trials Test

Most neonatal screening programs use isoelectric focusing or high performance liquid chromatography (HPLC) methods. All positive results must be repeated in the same sample for confirmation. Those cases that present an inconclusive or doubtful pattern by the technique of choice should be reassessed by another method, aiming to increase sensitivity and specificity. False-positive or false-negative results obtained in neonatal blood tests are generally due to collection problems, low resolution of the electrophoretic process and technical error in interpretation.

The hemoglobin patterns detected are described in order of the highest concentration of hemoglobin expressed, by universally established convention, as described below:

Pattern Eletroforético	Hemoglobin	Diagnosis
Default FA	HbF + HbA	No sickle cell disease. This phenotype is expressed by the predominance of Hb F at birth. These patients are not necessarily hematologically normal. It has no sickle cell disease, but may have minor thalassemia or other disorders of the erythrocyte series.
Default FAS	HbF + HbA + HbS	Sickle cell trait
FSC Standard	HbF + HbS + HbC	SC disease
Default FSD	HbF + HbS + HbD	SD disease
FS Standard	HbF + HbS	SS disease (sickle cell anemia); S / ß thalassemia or Hb S associated with hereditary persistence of fetal Hb (PHHF).
Standard FSA	HbF + HbS + HbA	S / ß + thalassemia. In some patients the percentage of Hb A is very small and may result in a FS phenotype. The definitive diagnosis may require assessment of parental laboratory tests or molecular study of the child or repetition of the child's laboratory examination after 9 months of age.

In addition to hemoglobin S, other hemoglobin variants can be detected by screening tests, the most common being hemoglobin C, D, E, J, and G. Bart's hemoglobin of alpha thalassemia can also be detected in neonatal screening.

If the child has received a blood transfusion (including intrauterine), blood collection is required three months after the last transfusion, or in the sixth month of life, when the hemoglobin profile is usually already established.

In neonates with hemoglobinopathies, especially those involving the beta globin chain, the screening tests will only find traits of the variant hemoglobin, and the characteristic hemoglobin profile obtained only after the sixth month of life. Therefore, it is important to remember that neonates diagnosed as having sickle cell disease should be reassessed after the sixth month of life, and a family study of possible cases should be performed.

After being repeatedly subjected to micro-circulation, the cell may lose the ability to return to its normal bicondonous discoid form.

According to the National Neonatal Screening Program (PNTN) of the Ministry of Health 3,500 children are born in Brazil each year with DF and 200,000 with a sickle cell trait, and it is estimated that 7,200,000 people are carriers of the sickle cell trait (HbAS) and between 25,000 to 30,000 with DF.4,7 The neonatal diagnosis of FD was implanted in Brazil through Portaria no 822, of the Ministry of Health, 06/06/2001, and in Minas Gerais, the Research Support Nucleus (Nupad) had already performed tests for the detection of hemoglobinopathies since 23/02/98. In Uberaba, during the first ten years of the program (1998 to 2007), 33,002 newborns were analyzed according to the Municipal Health Department of Uberaba and Nupad, of which 998 (3.02%) had sickle cell trait, 245 (0.74%) of the C haemoglobinopathy trait and 18 (0.05%) DF.

As in other chronic diseases, psychosocial aspects affect the emotional, social, and academic adaptation of patients with FD throughout their lives. There are a number of problems related to chronic illness, such as difficulty in family relationships, interaction with colleagues, academic performance and the development of positive self-image. Anxiety, depression, aggressive behavior and fear, related to the chronic and fatal nature of the disease, are frequent manifestations and intensify in the face of repeated pain and hospitalization [5,6]. During the adult phase, socioeconomic problems, such as unemployment, can Make gifts, as well as emotional and psychological problems, including relationship difficulties, low self-esteem, and concern for death.

Physiopathology - Clinical Signs and Symptoms [1]

The occurrence of vaso-occlusions, especially in small vessels, represents the pathophysiological event that determines the majority of the signs and symptoms present in the clinical picture of patients with sickle cell disease and has different degrees of severity. Such manifestations vary according to genetic, food, access to treatment and environmental factors. Among these changes, we have:

Pain Crisps- Secondary to intermittent microcirculation occlusions occur painful crises, causing tissue damage and pain. They are generally acute onset, lasting around 3 to 5 days, with infections, fever, hypoxia, dehydration and exposure to cold, higher levels of Hb, are factors that can trigger painful seizures. The pain more often affects the bones and joints, reaching the chest, abdomen and dorsal region (Watanabe, 2007).

Bone and joint injuries are frequent complications of sickle cell disease. They are due to falcization with ischemia and infarction of bone marrow (BM) and adjacent bone structures.

The painful crisis is the most characteristic clinical manifestation of sickle cell disease. It results from falcization with ischemic necrosis at the active MO sites. In childhood, the small bones of the hands and feet are the most affected. Later the active MO is located in the just-articular areas of the long bones, in the flat bones as the sternum, the ribs and the pelvis, and in the vertebral column. This is also the distribution of painful crises, which, although often interpreted as joint, most often involve the just-articular areas of the long bones.

Dactylitis or hand-foot syndrome is the first manifestation of pain in children; Characterized by pain and edema in the extremities.

Lower limb ulcers- Lower limb ulcers are among the most observed complications in adults with sickle cell anemia due to their high frequency, chronicity and resistance to the therapies used and their high rates of recurrence. In most cases, they develop in the ankles,

just above the malleoli and rarely in the pre-tibial region and dorsum of the foot. Often it is not possible to identify their onset that may be spontaneous or subsequent to trauma, even if small. Typically, ulcers form a central depression, surrounded by raised edges with surrounding edema. *Staphylococcus aureus*, *Pseudomonas* sp and *Streptococcus* sp and not infrequently Bacterioides (anaerobic), usually accompanied by a foul smell, are found in microbiological tests. These lesions can affect patients socially, as they compromise their productive capacity and are responsible for significant demand for health services (Van-Dúnem, 2004).

Acute thoracic syndrome (STA)- The second most common cause of hospitalization for sickle cell disease, acute chest syndrome is characterized by chest pain, cough, fever, dyspnea and recent pulmonary infiltrate. The etiology of this syndrome has been related to infections (*Streptococcus pneumoniae*, *Mycoplasma* and *Chlamydia pneumoniae*), such as pulmonary edema due to hyperhydration, gas embolism of the infarcted bone marrow and hypoventilation resulting from the use of narcotic analgesics administered to combat pain Thoracic (Van-Dúnem, 2004).

Splenic sequestration- defined as a rapid increase of the spleen accompanied by a decrease in hemoglobin levels of 2g / dL or more in relation to the basal level of the individual and with evidence of compensatory spinal response. It occurs mainly in children from 5 months of age and rarely after 6 years, being the second most frequent cause of death in these patients, because it can lead to hypovolemic shock.

It is characterized by sudden malaise, paleness, abdominal pain, and symptoms of anemia and hypovolemia (Santoro, 2010).

Priapism- can be defined as a failure in penile detumescence accompanied by pain that affects about 7% of male patients with sickle cell disease. Failure to detumescence may be due to numerous factors, such as: vasoconstriction in the blood outflow, excessive release of neurotransmitters, prolonged smooth muscle relaxation or even a combination of these episodes. The diagnosis is made through the clinical history, physical examination, laboratory data and specific radiological tests. Several signs and symptoms may be associated, such as: dysuria, seizures of generalized pain, fever and sepsis (Santoro, 2010).

Aseptic Necrosis of the Femur- Ischemic necrosis of the femoral head is another form of bone marrow necrosis, with particular implications due to the critical site of the lesion. The head of the femur may present several changes with or without rupture of the articular surface, depending on the age at which the infarction occurs. Although it can be observed from childhood, it is more frequent in late adolescence and young adults.

The lesion may be asymptomatic or cause pain in the hip, which worsens with movement. The continuous support of weight on the softened femoral head results in collapse and lesion of the articular surface.

The clinical course depends on the age at which the infarction occurs. Before age 18, it results in flattening of the femoral head with remodeling of the acetabulum and maintenance of joint function. The involvement of the mature femoral head is segmental, with collapse of the medial portion resulting in persistent pain and deformity. In the more advanced states there is reabsorption of the femoral head, signs of osteoarthrosis and total bone destruction with fibrosis and ankylosis [19].

Radiological Changes

There are 2 patterns of change, according to the maturity of the femoral head at the time of necrosis. In children, there is softening of the epiphysis, which with the continuous support of weight, takes the form of mushroom. The acetabulum conforms to this new form. The surface and joint space are preserved and the joint preserves function, with no symptoms in adult life. In older patients necrosis is segmental, affecting more often the anterosuperior region. Continuous weight support may lead to depression of the softened ischemic segment, with reduced joint space and pain upon mobilization. Joint surface rupture and femoral head collapse produce various radiological signs including dense areas, lytic lesions and fragment sequestration.

Diagnosis

In well established lesions the diagnosis is easy, but early detection is essential to stop the process and minimize irreversible changes. The most sensitive method for early diagnosis appears to be magnetic resonance imaging [13-15], which demonstrates lesions when plain radiography is normal.

Treatment

It depends on the state of the disease. The effective treatment is based on the early diagnosis, before the installation of the joint injury. In these states, avoidance of weight support may allow healing with preservation of the femoral head shape. In the more advanced states, when there is pain and limitation of movement, the treatment is symptomatic. In cases of persistent and intense symptoms, the treatment is the placement of a hip prosthesis. Complications are common, although short-term results are good [4].

Brain stroke- Stroke occurs due to falcization in the fine caliber intracranial arteries, with the most common being the territories of the middle cerebral, internal carotid and anterior cerebral arteries. It is characterized by focal neurological deficit, seizures, aphasia, and sometimes sudden onset intense headache, with hemiplegia being the most frequent clinical presentation (Van-Dúnem, 2004). It occurs most often between 3 and 10 years of age. It is recurrent in up to 50% of these patients in the first 3 years after the accident. Chronic transfusions reduce the recurrence of these episodes by up to 90% (Watanabe, 2007).

Several complications of the Central Nervous System have been associated with sickle cell anemia, as can be seen in table, with the main ones being infarction in 70 to 80% of the cases and intracranial hemorrhage. Studying children with sickle cell anemia, Powars., *et al*. Observed an incidence of 0.70% of stroke / year in the first two decades of life, and Jamaica's study showed a prevalence of 7.8% up to the age of 14 years [17-19].

Occlusion, partial or complete, occurs in the great cerebral vessels and it seems to be due to progressive stenosis, superimposed on thrombus formation at the site. Histological studies have shown that vascular damage is due to the increase in the thickness of the segmental layer, due to the extensive proliferation of fibroblasts and the smooth muscle of the intima, without the presence of inflammatory signs. Secondarily, in about 30% of the patients, an extensive collateral circulation can develop, giving an appearance known as Moyamoya. These patients follow the clinical course usually seen in other individuals with Moyamoya due to another etiology, which is cerebral infarction as a child and development of hemorrhagic stroke later [18,20,23-25].

Stroke patients usually show obvious clinical signs. The most common neurological symptom is hemiparesis, followed by aphasia or dysphasia, convulsions and monoparesis. Headache has been found common but, in isolation, is not a predictive factor of stroke. Rare patients may present, as an initial manifestation, a transient ischemic attack or even a coma [25].

The diagnosis of stroke is usually made from clinical data; however, patients can be evaluated by computed tomography or magnetic resonance imaging. Angiography should be performed in cases where the diagnosis has not been made by tomography and / or magnetic resonance imaging, and in these cases, patients need transfusional therapy prior to the examination, with the objective of preventing falciparation and consequent worsening of neurological manifestation [24,25].

Exsanguine transfusion, manual or automated, is the immediate therapeutic intervention that can decrease the progression of the disease and revert the clinical manifestations. In the absence of transfusion therapy, the clinical course of cerebrovascular injury is progressive. The goal of transfusion therapy, both early and in the chronic phase of treatment, is to decrease the percentage of hemoglobin S to less than 30% [6,13-15].

Other treatment measures during the acute episode depend on clinical manifestation: assisted ventilation, anti-edema drug therapy, anticonvulsant therapy, etc. and therefore the evaluation and follow-up of a neurologist is important [13-15].

Relapses of stroke episodes occur in about 67% of patients between 12 and 24 months after the first episode and 80% of recurrent strokes occur in the first 3 years, when they are not chronically transfused. Even transfusional patients may present a recurrence rate of 10%. To prevent recurrent attacks, patients should be kept on a chronic transfusion schedule, every 3 or 4 weeks, with Pre transfusional hemoglobin between 8 and 9 g / dl and post-transfusional hemoglobin between 10 and 11 g / dl [21,22].

We must always bear in mind the risks of a chronic transfusion program, such as: transfusion reactions, infections, erythrocyte alloimmunization, and iron overload. The ideal time for the maintenance of transfusion therapy is not clearly defined, since there is no way to predict which patient will relapse, but it should be maintained for at least 2 years. The use of desferrioxamine per SC infusion pump at a dose of 30 to 40 mg / kg for 10 hours, 5 to 7 times per week, is recommended to reduce levels of iron overload [13-15,25].

Rretinopathy- The phenomenon of vaso-occlusion, which occurs throughout the organism, can also be observed in the microvasculature of the eye [8-15]. This complication may or may not lead to impaired vision depending on the tissue involved and the Anatomical location of the vessel-occlusion. For example, the microvasculature of the conjunctiva often has areas of vessel occlusion. In 1961, Paton [11] characterized these vascular alterations, much found in SS individuals [8], as multiple capillary segments, in the form of a comma or spiral, separated from the vascular network of the conjunctiva. The affected tissue (conjunctiva) is not dependent on high levels of oxygen, it survives well, and the patient therefore has no visual symptoms [8,13-15,17]. On the other hand, the retina, the thin membrane that fills the inner and posterior wall of the eye, is extremely sensitive to hypoxia [3,6,9] and therefore susceptible to lesions that can lead to significant visual symptoms.

The initial event in the pathogenesis of retinopathy of FD is vaso-occlusion, which usually occurs in the peripheral region of the retina and is strongly associated with the abnormal interaction between irreversible sickle cells and the vascular endothelium [6,19,20]. The diameter and Rheological characteristics of the blood in the arteriolar bifurcations suggest these sites as a site of initiation of the vaso-occlusion phenomenon [21]. Other studies, using sophisticated techniques, show that occlusion can also occur in capillaries, venules and veins. However, arteriolar occlusion is predominant at the onset of retinopathy and does not necessarily indicate that the patient progresses to the proliferative phase of retinopathy [6,22].

Vaso-occlusion results in several pathophysiological phenomena. The main findings of the non-proliferative phase of retinopathy are:

1. Small intra-retinal hemorrhages, possibly due to ischemic necrosis of the vessel wall, called salmon patches, a name attributed to the orange coloration due to the degradation of the blood [3,6,23]. The hemorrhage then becomes yellow and then white, disappearing without a trace.

2. Hyperpigmented lesions in deeper or sub-retinal haemorrhages, called black sunbursts, which resemble a chorioretinitis scar [3]. These lesions have the diameter of half an optical disc, which can reach the size of up to two optical discs, and have spicular borders [24].

Proliferative retinopathy (PR) has a common non-proliferative genesis. The chronology of events may be accompanied by angiographic examinations of the retina, angio-fluoresceinography. RP was classified by Goldberg in 1971 in five stages [3,18,25]. This researcher proposed such a classification, correlating the stages of RP with the order of their appearance, based on detailed clinical data through the mapping of the retina and angio-fluoresceinography [18,25]. Stage I is characterized by definitive arteriolar occlusion, with consequent retinal hypoxia and rearrangement of adjacent capillaries. In the next stage (stage II), neovasal budding, with possible dilatation, is initiated in the search to join the vascular and avascular retina. In stage III, under the action of angiogenic events, pre-retinal neovascularization

occurs, forming a fan image that resembles the marine invertebrate Gorgonia flabellum (sea fun) [3,25]. These neovascular structures, developed from arteriovenous loops or junctions, very often suffer from auto-infarctions, possibly due to the unusual characteristics of the flow [6,24]. New vessels are fragile, immature and adherent to the vitreous gel. This facilitates the occurrence of vitreous hemorrhage and characterizes stage IV of RP in the DF. When this bleeding reaches the visual axis, it causes symptoms of "flying flies" and decreased or lost vision. The repetition of these hemorrhagic phenomena potentiates the traction created by fibroglial tissue and vitreous adhesion to neovascularization, leading to rupture, retinal detachment and loss of vision (stage V), the final stage of sickle cell proliferative retinopathy [6,23,25]. Bonanomi (1997) reveals that small lesions, with circumferential extension above 30°, are capable of causing vitreous hemorrhage. The nonproliferative or basic retinoid corresponds to stages I and II, whereas PR corresponds to stages III, IV and V [25]. The chronology of what occurs in the retina can be documented through Of angiographic examinations of the retina, angio-fluoresceinography [6,25].

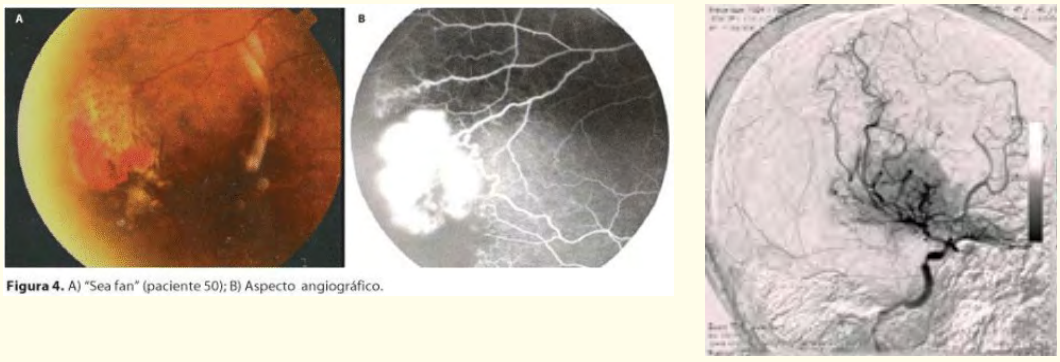

Figura 4. A) "Sea fan" (paciente 50); B) Aspecto angiográfico.

This correlation of vascular alteration is responsible for the greater amount of oxygen released into the CNS, which during treatment with hyperbaric oxygen can lead to consultation. In just 15 minutes from exposure to O_2 to one hundred percent.

Anemia: Most sickle cell patients have chronic anemia, with hemoglobin levels between 6.0 and 11.0 g / dL, and erythrocytes with a half-life of 10 - 12 days versus the usual 120 under normal conditions. The chronic character of anemia associated with increased tissue oxygen delivery capacity by HbS conditions that these patients are oligosymptomatic if hemoglobin is within the above limits. A fall in baseline hemoglobin level, with exacerbation of anemic symptoms, may be a sign of aplastic crisis, of sequestering (often splenic) or of infection. The aplastic crises are due to suppression of erythropoiesis, usually after infectious processes, particularly parvovirus B19 (Van-Dunem, 2004).

Prevalence - Life Expectation

Individuals with hemoglobinopathies have a shortened life expectancy (Pereira et al, 2008). In 1994, the National Institute of Health (NIH) estimated that the median survival for individuals with sickle cell anemia was 42 years for men and 48 years for women. Thus, it is understood that infant mortality contributed significantly to shortening this survival. Three decades ago, only half of sickle cell children reached adulthood, however, improvements in medical care of these individuals have increased their survival.

Studies have shown that in countries where neonatal screening for hemoglobinopathies was instituted by providing follow up of patients in specialized centers, overall mortality in these children was reduced from 80% to 1.8% (Cehmob, 2007). Figure 1 below shows neonatal screening as an impact factor in the sickle-cell death rate [18].

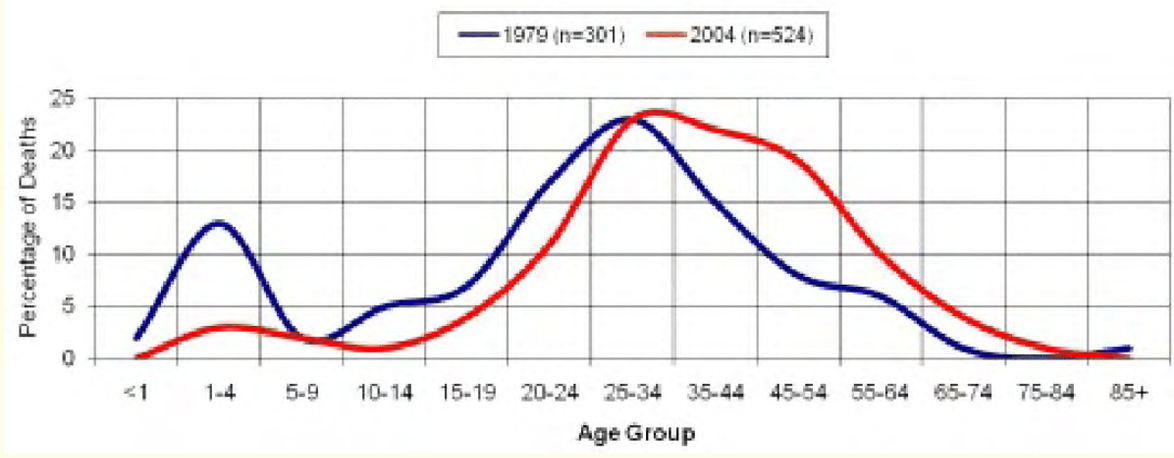

Figure 1: *Neonatal screening as a decisive factor in decreasing the mortality rate due to sickle cell disease Source: Centers for Disease Control and Prevention, 2010.*

To evaluate the behavior of previous periods (1974) and later (2004) to the implantation of neonatal screening.

According to Quinn (2004), measures that modify the percentages of mortality of patients with sickle cell disease include: early diagnosis in newborns (foot test) and referral to specialized centers so that regular follow-up and treatment of these children can be done, Through the use (Such as anti-influenzae, anti-hepatitis A, anti-varicella, heptavalent conjugated antipneumococcal, and antipneumococcal polysaccharide 23-valent).

Figure 2 highlights that from the year of the discovery of sickle cell disease (1835 or 1910), life expectancy increased as the previously highlighted measures were implemented.

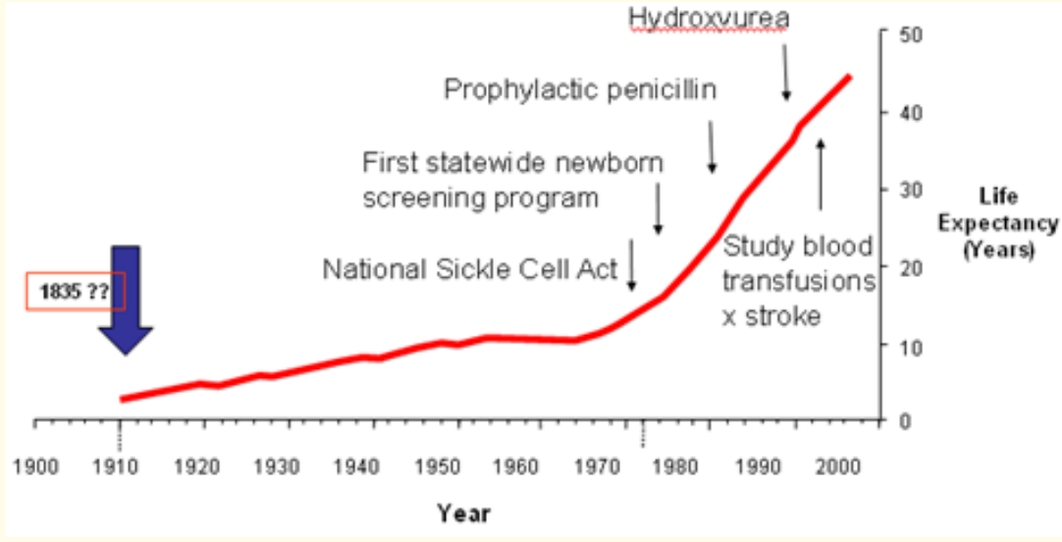

Figure 2: *Life expectancy of patients with sickle cell disease over time. Source: National Institutes of Health, 2002.*

Conclusion

The pathophysiology of sickle cell disease is based on tissue ischemia and hypoxia, with oxygen therapy hoiperbarica as a treatment of choice that enables hypoxic tissues. It is best indicated in multiplace hyperbaric chambers, since in multiplace diving we use oxygen at 100 percent with gas mixture intervals, thus not allowing oxygen poisoning. It is different from the monoplace where the chamber is already filled by 100 percent oxygen. Patients who are at a higher risk of convulsing with hyperbaric oxygen are those who already present vascular alterations in snc and retina. It is possible to make a preliminary analysis of the patient and to choose the best treatment plan. Examination of the fundus of the eye is through direct fundoscopy. When observing vascular changes in the mid-retinal period or lesions that indicate more cases severe cases of retinopathy should correlate with the presence of vascular alterations in CNS. Alterations of great intracranial arteries becomes a counter indication relative, since there is a risk of intoxication within the first 15 minutes of pressurizing the single-seat camera.

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Volume 5 Issue 5 March 2017