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«PNEUMATIC RETINOPEXY AND PATIENTS AERIAL TRANSPORT»

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INTRODUCTION

There are many vitreoretinal surgeons in all the world that use very often sterile air and expansive intraocular gases as pneumatic retinopexy (gas tamponades). 1, 7, 9, 10, 11.

The air doesn't expand, its volume neither change and its complete reabsorption time is proportional to the amount injected. Sebag, among others authors, uses to inject, in selected cases, 0.8 cc. of sterile air through pars plana. They argue that it is cheaper and less conflict since a legally point of view. 13.

We must add to this approach that ought to be performed just only in cases where vitreous traction doesn't exist, so the air, being no expansive, cannot eliminate the aforementioned traction. 8.

The SF6 or hexafluoridic sulfur, or hexafluor of sulfur and the C3F8 or perfluoropropan are the expansive gases most used by surgeons as tamponades. 10.

There are many physical laws that influence the behaviour of expansive gases in the eye modifying the volume of gas bubble relatively with changes in altitude. We all know that these substances are insoluble in water, and can therefore remain in the vitreous cavity for a longer time than in the air. 3.

We also know that when a bubble of SF6 is injected, its volume become 1.5 times greater in 24 hours and reabsorbs in 14 days. The C3F8 on the other hand, increases in volume four times in 72 hours, and total reabsorption takes places in about 25 days. All this is under normal conditions. 8.

The objective of this report is to analyse the different types of actual aircrafts and its characteristics of flying, to determinate the quantity of gas to input into the patient's eye, to consider the differences between altitude of the place where retinopexy is performed, to evaluate the way of more safe transportation and the final destination of the patient after the procedure in order to clarify the most of controversies arisen among many specialists.

PERSONAL EXPERIENCE

Based on the Boyle-Mariotte law, a decrease in barometric pressure produces an increase in the volume of gas in the blood, which lead shaping of bubbles and expansion of free gases. 12.

Concerning to the eye, intraocular pressure (IOP) becomes higher with possible adverse consequences.

It is therefore very important to take into account the altitude of the place in which we perform pneumatic retinopexy, as well as the altitude of the place where the patient is going to stay lastly.

In Spain there is no risk for patients who undergo pneumatic retinopexy. Ávila, the country´s highest city, is only 1.225 m. above the sea level. However, there are many cities in the world at an altitude higher than 2.000 m., for instance: Gartok in the Tibet (China), with 4.343 m. La Paz, capital of Bolivia, with 3.720 m. Cuzco (Peru), 3.560 m. Duarte Peak (Dominican Republic, central chain of mountains), 3.175 m. Leadville, Colorado, United States of America, 3.108 m. Addis Ababa, capital of Ethiopia, 3.019 m.Quito, capital of Ecuador, 2.836 m. Bogotá, capital of Colombia, 2.632 m. Tukucha, in Nepal, 2.500 m. México City, 2.250 m., etc. Table 1.

Gartok (Tibet)	China	4.343 m.
La Paz	Bolivia	3.720 m.
Cuzco	Perú	3.560 m.
Duarte Peak	Dominican Republic	3.175 m.
Leadville (Colorado)	United States of America	3.108 m.
Addis Ababa	Ethiopia	3.019 m.
Quito	Ecuador	2.836 m.
Bogotá	Colombia	2.632 m.
Tukucha	Nepal	2.500 m.
México city	México	2.250 m.
Ávila	Spain	1.225 m.

TABLE 1. *The world´s higher cities.*

A patient who is going to travel to one of these places after pneumatic retinopexy with expansive gases will have a 40% volumetric increase of the tamponade in the eye. This will produce a collapse of the chorioretinal circulation, secondary to the increase in IOP and a consequent central retinal artery occlusion when IOP becomes higher than the maximum pressure of the central artery. This, in our opinion, could be another possible explanation of the «blackout syndrome» with its irreversible loss of visual functions, which occurs in some patients after about 2 hours traveling in fast vehicles, like nonpressurized airplanes or helicopters, when sudden changes in altitude are involved.

Traveling by land in mountain territories is safer in this respect, because the time of arrival is more protracted and this allows the aqueous humor to drain, bringing IOP to normal levels. 2, 4, 5, 6, 8.

When the procedure is performed at a high altitude and the patient then travels to a place near the sea level (760 mm. of Hg), an inverse effect will occur. The volume of the gas diminishes by 40% in addition to the spontaneous reabsorption, resulting in very poor effect of the tamponade. 3.

Traveling by air carries no risk patients with pneumatic retinopexy. Although commercial airplanes normally fly over 10.000 m., the presence of compressed air inside the cabin makes interior pressure equivalent to that of lower altitudes. Passengers therefore travel in an atmosphere that will not provoke hypoxic episodes or dysbaric effects, even on long-distance routes.

We must consider two altitudes. First is the real altitude, also called flight altitude, which corresponds to the airplane altitude over the sea level and is regulated by the altimeter. The other altitude, which is more important for our purposes, is the cabin or artificial or simulated altitude. 5.

The Concorde, the airliner that has the highest flight altitude at cruising speed, travels at 18.500 m. However, its cabin altitude is 1.855 m., which creates an optimal atmospheric environment for passengers inside. Similarly, the DC-9 has a maximun altitude of 10.650 m., with a cabin altitude of 2.440 m., etc. Table 2.

AIRPLANE MODEL	*MAXIM ALTITUDE*	*CABIN ALTITUDE*	*ENDURANCE*
DOUGLAS DC 9	10.650 m.	2.440 m.	2.037 km.
BOEING 727	12.800 m.	2.335 m.	3.241 km.
DOUGLAS DC10	13.700 m.	2.365 m.	9.200 km.
BOEING 747 (JUMBO)	13.730 m.	2.370 m.	12.300 km.
CONCORDE TSS	18.500 m.	1.855 m.	8.000 km.

TABLE 2.

Only an accidental decompression, due to a cabin break or a break III on the fuselage, may be a potential risk for patients with pneumatic retinopexy. The risk entity in such a case would be inversely proportional to decompression speed. Fortunately, such events are extremely rare thanks to the security systems of our airlines.

Small, private planes normally do not have pressurized cabins. For this reason they are only allowed by Visual Flight Regulations (VFR) to fly below 3.000 m. (10.000 feet). Beyond those limits, the pilot would feel the effects of hypoxy from hypobary, better known as airsickness or aviator sickness. 8.

Therefore, transport by private airplanes, which is usually carried out at an altitude of far less than the 3.000 meters limit, can be considered equally safe for patients with pneumatic retinopexy.

CONCLUSIONS

1. There is not any risk for transportation of patients with pneumatic retinopexy in nonpressurized airplanes because the highest altitude of flight allowed is supremely lesser than 3.000 m., compatible with all kind of life altitude.

2. The contemporary commercial aviation, with airplanes having super modern, sophisticated and pressurized cabins, is very safe. Only an unforeseen accident such as a failure, a shot or others, can cause an explosive decompression that rarely happens due to the personal of security existing at the airports, whom, most of time, ought to avoid the terrorist attacks responsible of those kind of eventualities.

3. Traveling by land (trains, busses, cars, etc.), even in mountain routes, doesn't represent any risk, especially if the final destination city settles below 2.000 m. height.

4. Even though, it is very important to know the amount of gas to be injected, the altitude of the city or place in which we practice the pneumatic retinopexy procedure and the arriving time to the habitual residence, except in Spain and similar by its inherent geographic conditions, in order to avoid tremendous ocular complications feasible in another parts of the world.

SUMMARY

The author exposes the importance of the pneumatic retinopexy applied to the aviation, especially the sporting aviation, sport that the author practices with a lot of enthusiasm since long time because of his condition of private pilot, activity that he combines with the practice of ophthalmology and the practice of clinical aviation medicine.

He describes how harmless could the transportation be in pressurized airplanes, excepting few cases. He also points out the absent of risk using any vehicle by land in mountain territories when the final destination or the trajectory of the way route is not higher than 2.000 m. of altitude.

He emphasizes that in sporting aircrafts with nonpressurized cabins, the highest altitude of flight subjected does not condition the appearance of phenomena causing the altitude syndrome or the aviator sickness, excellent reason to recommend that way of transportation, in patients previously treated by means of pneumatic retinopexy, combined or not by physic therapy such as laser or cryocoagulation.

Finally, the author publishes two tables where we can observe different models of commercial airplanes of passengers, reaction engines, the maximum real altitude and flight endurance. Compares the highest altitude of flight (maximum altitude) versus cabin altitude, expressed in meters and kilometers and a relationship of the higher cities in the world. Table 1 and 2.

KEY WORDS: Pneumatic retinopexy. Hipoxy. Dysbarism. Decompression.

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