Original Article

Decompression chamber runs for screening and training of HALO paratroopers and training of fighter aircrew

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ABSTRACT

Sneak missions dropping small groups of battle ready soldiers from high altitudes exposes paratroopers to pressure variations affecting the air containing cavities of the body. Evaluation of Eustachian tube functions, based on the ability to open the tube actively by various manoeuvres should be done by realistic simulation of flights in a pressure chamber to minimize the chances of Otitic barotrauma. The present study was carried out in two phases, Phase-I at Para Training School, Agra and Phase-II at Institute of Aerospace Medicine, Bangalore. In Phase-I, 25 healthy male trained paratroopers were examined for any signs or symptoms related to otitic barotrauma before and after a freefall from 12,500ft. In Phase-II, 50 Armed Forces healthy male paratroopers from Parachute Regiment Training Centre, Bangalore were chosen. An ear clearance run following standard briefings and monitoring was conducted simulating three protocols viz, 3000ft/min descent rate from 10,000ft to ground, 6000ft/min and 10000'/min descent rate from an altitude of 12,500 ft. Tympanometry was done before and after each simulation and results compared amongst protocols using a non-parametric test for matched samples (McNemar's). In Phase-I, 44% of the paratroopers showed signs of congestion whereas none reported any symptoms. In Phase-II, comparison of 3000ft/min vs 6000ft/min descent rate showed a statistically significant change in pain, discomfort and congestion whereas; tympanometry findings were not statistically significant. A significant difference in congestion was noted between 6000ft/min and 10,000ft/min descent rates. Pain, discomfort, congestion and tympanometry findings between 3000ft/min and 10000ft/min were all statistically significant. In view of the findings, an ear clearance protocol with descent rates of 10,000ft/min from 12,500ft to ground level would be ideal for combat freefallers, as the pressure change is similar to that encountered during actual freefall. Given the limitation of the existing chambers and the insignificant difference in symptoms and tympanometry findings between the 6000ft/min and 10,000ft/min descent protocol, a 3000ft/min descent protocol followed by a 6000ft/min descent rate protocol, is acceptable for simulation for ear clearance run in combat freefallers. The findings of the study have implications for altitude chamber training of military aircrew as well as design protocols to be adapted in future generation of altitude chambers in the Armed Forces.

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Military has been doing High Altitude Low Opening Jumps (HALO) for years to furtively insert Special Forces soldiers deep behind enemy lines. Above 25,000 feet a plane is invisible, although a dull murmur above the clouds may be heard. On the radar, it looks like a commercial flight if noticed at all and troops can fall from its belly silently, undetected. In the 1950s, at the height of the Cold War and the nuclear age, the most precise way to deliver a nuclear device behind enemy lines was by paratroopers. Back then, HALO operations were so secret that both the US Army and the Marine Corps were working on them without the other knowing. HALO was first used in combat in the Vietnam War and has been a staple of Special Forces deployment ever since [1, 2].

The human beings evolved on terra firma and function well within these surroundings, but suffer loss of efficiency when operating in different

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environments. Advancement in equipment and techniques enables single aircraft sneak missions to drop battle ready soldiers from high altitudes. This exposes paratroopers to pressure changes due to change of environment with resultant effect on the air containing cavities of the body. The evolution of an air containing middle ear cavity has given humans a structure that largely overcomes the pressure changes between the envoirnment and the air cavities, but becomes a liability with exposure to the pressure changes encountered during freefall and in flight. Normal otologic function and prevention of injury during such exposures, requires appropriate middle ear pressure equilibration via a functioning Eustachian tube (ET). Inability to clear the ears during freefall and flight can be incapacitating and a threat to flight safety.

Normal tubal function is indispensable and its evaluation necessary. Free-fallers should be able to open the ET actively by various manoeuvres and at a given instant, repeatedly, during a sudden change in pressure. Ideally, it should be tested during simulated flights in a pressure chamber, but relies on sensations experienced and reported by the test subject and therefore may be limited or even misleading [3]. To prevent this, tympanometry to evaluate ET functions must be used. Compliance of the tympanic membrane, middle ear pressures and the continuity of ossicular chain can be examined by tympanometry [4]. The aim of the study is to examine the effects of actual and simulated HALO jumps, evaluate the present protocol of ear clearance run and recommend a protocol that should simulate and test the tubal function to as near as the actual pressure changes that occur during HALO jumps or in flight, thereby, reducing the occurrence of otitic barotrauma.

Material and Methods

The study was carried out in two Phases, Phase-I at Parachute Training School (PTS), Agra and Phase-II at Institute of Aerospace Medicine (IAM), Bangalore.

Phase-I. In all, 25 healthy Armed Forces male paratroopers trained in freefalling in the age group 20-50 yr (26.68±5.11) were selected for the study after a thorough history and clinical examination. All subjects were non-smokers and were not addicted to any drug. All answered a questionnaire consisting of 10 questions related to para jumping:- (i) What is the protocol of jump (HALO) followed, (ii) height of opening, (iii) Time of freefall, (iv) How many jumps have you done, (v) Type of jumps, (vi) Any jumps done with ear/throat/nose problem, (vii) Any problems during previous jumps, (viii) What method is used to equalize ear pressure, (ix) Which part of the jump is problem felt and (x) Any problem when door is opened? A detailed ENT examination was carried out including auroscopy, throat, nose and chest examination. Auroscopy was done to assess the middle ear functions in the form of intact tympanic membrane, movement of tympanic membrane with valsalva, menocure congestion, retraction, perforation or any tympanosclerotic patch (TS)/thinning of tympanic membrane or scarring. The throat was examined for any upper respiratory tract infection, tonsillitis or any obvious deformity. Nose was examined for the patency of the nasal passage, polyps or inflammation/hypertrophy of the turbinates. All jumps were carried out between 0615 h and 1100 h. All paratroopers were experienced with an average of between 20-100 HALO jumps.

All the paratroopers jumped from an AN-32 aircraft from a height of 12,500ft and opened their parachute at an altitude of 4,000-5,000ft. Freefallers were questioned regarding symptoms of pain, discomfort, giddiness or vertigo. Auroscopy was repeated after the jump and the changes were compared to the pre jump findings. Tympanometry was not done pre or post jump due to unavailability of the apparatus.

Phase-II. 50 paratroopers in the age group of 20-40 yr (22.14±4.67) from Parachute Regiment Training Centre (PRTC), Bangalore were enrolled for the study. The second phase of the study was done at IAM in which, the protocol for combat freefall was evaluated by simulating a more realistic freefall. An informed consent was taken from all subjects after explaining the risks and limitations of the study. Ethical clearance from the Institute ethical committee was taken for carrying out the under mentioned protocol.

All the subjects were healthy Armed Forces personnel and this was ascertained through history and a thorough clinical examination. History of allergy, giddiness, vertigo, ear pain or surgery/ hospitalization for any ear, nose or throat problem was taken. All subjects were non-smokers and were not addicted to any drug. Thorough ENT examination was done to rule out any existing infection of the upper respiratory tract and ear. The throat was examined for any upper respiratory tract infection, tonsillitis or any obvious deformity. Nose was examined for the patency of the nasal passage, polyps and inflammation/hypertrophy of the turbinates.

The present protocol of 3000ft/min descent rate from 10,000ft (as per IAP 4303, [5] 3rd Edition (2003) and AFO 08/91) along with a descent rate of 6000ft/min and 10,000ft/min from an altitude of 12,500'ft was simulated in the hypobaric chamber. Descent rate of 6000ft /min was chosen before exposing the subjects to a descent rate of 10,000ft/ min (the actual pressure change during freefall in HALO jumps). This was to simulate an in between descent rate and to avoid sudden exposure to10,000ft/min descent and keeping in mind capabilities of chambers in IAF. Royal Air Force (RAF) also uses 6000ft/min descent rate in their decompression chamber test protocol to simulate pressure changes experienced in aircraft for all aircrew [6]. The simulation involved an ascent to 12,500ft at an ascent rate of 3000ft/min followed by a descent at the three descent rates described above. All the subjects were taught the valsalva manoeuvre and briefed of the procedures of equalizing middle ear pressure and were to report any problem or symptom during simulation.

Complaints if any, viz. pain, discomfort, congestion or any related symptom or sign related to the ear, sinuses or alimentary tract were recorded before the simulation and after each simulation. Auroscopy was done to assess the middle ear functions in the form of intact tympanic membrane, movement of TM with valsalva, congestion, retraction, perforation or any TS patch/thinning of TM or scarring and the same repeated after each simulation. Tympanometry of all subjects before the simulated descent of 3000ft/min and then after each descent protocol was done to compare and to detect any middle ear pressure changes. The type of tympanometry curve was noted before and after each protocol simulation and a printout taken for later reference and interpretation.

Analysis of Data. In Phase-I of the study the percentage of paratroopers who complained of any symptoms and those with congestion pre and post jump was noted. In Phase-II, the analysis involved comparison of pain, discomfort, congestion and tympanometry changes after each protocol. All the parameters were compared statistically (3000ft/min vs 6000ft/min, 3000ft/min vs 10,000ft/min and 6000ft/min vs 10,000ft/min simulation).

As the data had only two results “Yes” or “No”, a non-parametric test (McNemar’s Test for matched samples) was used. The significance level and χ^2 values were noted. The significance level was set at $p<0.05$.

Results

Phase I. 44% of the paratroopers showed signs of congestion (Grade-I Teed's) [7] whereas none of them reported any symptoms. The same is presented in Table 1.

Table 1: Findings after freefall from 12,500ft (HALO Jump) [n=25]

Findings	No. (Percentage)
Pain	0 (0%)
Discomfort	0 (0%)
Congestion	11 (44%)

- **It is to be appreciated that none of the paratroopers reported any pain, discomfort despite a good number were found to be positive for congestion on Auroscopy (TEED's 1)**

Phase II. Findings of the different ear clearance protocols of 3000ft/min, 6000ft/min and 10,000ft/min are presented in Table 2 and are as follows: -

(i) 3000ft/min descent rate: All subjects cleared the ear clearance run without any symptoms or clinical findings.

(ii) 6000ft/min descent rate: Nine subjects (18%) complained of pain and ten (20%) complained of some discomfort during or after the run. After the run nine (18%) subjects had congestion of the tympanic membrane (Grade-I Teed's). Five (10%) of these subjects showed a type 'C' curve on tympanometry indicating a negative pressure in the middle ear cavity.

(iii) 10,000ft/min descent rate: None of the subjects who had a symptom or signs at 6000ft/min were given this run to avoid barotrauma of a higher grade. They were however, included in the calculation of results, as they would have had signs or symptoms at 10,000ft/min descent also. Two additional subjects complained of discomfort i.e. 10+2 =12 (24%) and eleven additional had congestion i.e. 9+11 = 20 (40%). Tympanometry revealed a negative ear pressure in four more subjects i.e. 5+4 = 9 (18%).

The comparison of findings in the different protocols is presented in Table 3 and is as follows: -

(i) 3000ft/min vs 6000'/min descent rate: The results showed a statistically significant change in respect to the findings of pain (χ^2=7.11; p<0.008), discomfort (χ^2 =8.10; p<0.004) and congestion (χ^2=7.11; p<0.008). Tympanometry findings (χ^2=3.20; p<0.074) were not statistically significant.

(ii) 6000ft/min vs 10,000ft/min descent rate: A significant difference in congestion (χ^2 =9.09; p<0.003) was seen when compared to the 6000ft/min protocol. No other parameter showed any significant difference.

Table 2: Findings after simulated Freefall (HALO Jump) at the rate of 3000ft, 6000ft and 10,000ft/min in the decompression chamber

Findings	Simulation Rates		
	3000ft/min	6000ft/min	10,000ft/min
Pain	0	9 (18%)	9 (18%)
Discomfort	0	10 (20%)	10+2 = 12 (24%)
Congestion	0	9 (18%)	9+11 = 20 (40%)
Tympanometry	0	5 (10%)	5+4 = 9 (18%)

Table 3: Comparison of the findings after simulated Freefall (HALO Jump) at different descent rates using McNemar's Test

Findings	Rate of descent vs Rate of descent	χ^2; p
Pain		
	3000' vs 6000'	**(χ^2=7.11; p<0.008)**
	3000 vs 10,000	**(χ^2=7.11; p<0.008)**
	6000' vs 10,000	($\chi^2 = \infty$; p< 0)
Discomfort		
	3000' vs 6000'	**(χ^2=8.10; p<0.004)**
	3000 vs 10,000	**(χ^2=10.08; p<0.002)**
	6000' vs 10,000	(χ^2=0.50; p<0.479)
Congestion		
	3000' vs 6000'	**(χ^2=7.11; p<0.008)**
	3000 vs 10,000	**(χ^2=18.05; p<0.000)**
	6000' vs 10,000	**(χ^2=9.09; p<0.003)**
Tympanometry		
	3000' vs 6000'	(χ^2=3.20; p<0.074)
	3000 vs 10,000	**(χ^2=7.11; p<0.008)**
	6000' vs 10,000	(χ^2=2.25; p<0.134)

(iii) 3000ft/min vs 10,000ft/min descent rate: - Pain (χ^2 =7.11; p<0.008), discomfort (χ^2 =10.08; p<0.002), congestion (χ^2 =18.05; p<0.000) and tympanometry (χ^2 =7.11; p<0.008) all were statistically significant.

Discussion

Combat freefall is practiced during time of peace for requirement of freefalling into the enemy territory during war situations. It is used to penetrate into enemy area, without the need to cross the border on ground and for faster deployment to the exact attack point. This places an advantage in terms of time, exact area to be captured and can catch the enemy in an unprepared situation. Combat jumps are of three types:

(a) Static line. Jumping from an altitude of 1250ft – 2000ft and immediately deploying the parachute. The paratrooper is under the deployed parachute in 3-5 seconds and the rate of descent is approximately 14 – 18ft/ sec depending on the type and size of parachute. These jumps do not pose any medical problem except for landing injuries, which are common to all jumps if the correct landing technique is not followed.

(b) HALO (High Altitude Low Opening). Jumping from high altitude i.e. altitude above 10,000ft and freefalling to an altitude of below 4,500ft and then pulling the D ring to deploy the parachute. Depending on the height of jump and deployment of parachute, time of freefall varies from anything between 20 sec to 2-3 minutes. HALO is the military term for skydiving and sport skydivers call this no-contact Repair work.

(c) HAHO (High Altitude High Opening). Jumping from high altitude and immediately opening the parachute. HAHO jumps are generally done above 13,000ft and require supplemental O_2 to avoid the effects of hypoxia in terms of time of useful consciousness. This poses a problem as the paratrooper remains above 10,000' for a substantial amount of time. Dcompression Chambers also is a problem and oxygen pre-breathing is necessary to avoid any chance of DCS [8, 9]. Sport skydivers call this cross country.

Military skydiving rigs are known as HAPPS (High Altitude Precision Parachute System) or 'stealth parachutes' because they cannot easily be seen from the ground. The handles for opening the parachute are in the same place but there are a number of attachment points for additional equipment and a harness for the Oxygen equipment. The typical canopy size is 360 sq ft on both the main and reserve parachute.

United States Air Force (USAF) and the HALO jumpers club in the US jump from altitudes upto 30,000ft [1] whereas in INDIA the IAF and the Army jumps from an altitude of only 12,500ft–13,000ft and therefore the requirement of supplemental oxygen is not there. HALO jumps do not pose the problems seen in HAHO jumps but leaves the paratroopers with a chance of barotrauma as the pressure changes during freefall are so high that a non-compliant. ET could render the paratrooper incapacitated after the jump.

A paratrooper jumping from an altitude of 30,000ft and freefalling until the chute is opened at 4500ft to 3000ft will freefall for approximately 2-min±10 sec and could experience pressure changes of the magnitude of up to 240 mmHg/ min i.e. at a rate of 176 ft/sec descent rate. This can be calculated considering an initial time to terminal velocity as 10-12 sec and thereafter 5 sec for every 1000' descent or the formula as below:-

Terminal velocity = $[(2 \times \text{Drag})/\ \rho \text{CdA}]^{1/2}$

where, Drag = weight × acceleration due to gravity (i.e. $9.8 m/s^2$)

CdA = Drag coefficient × Surface area of the individual (taken as a constant - 0.59) [10]

ρ = density of air at that altitude

After calculation of the terminal velocity at different altitudes taking the pressure differences, a table is drawn and the difference in the pressures can then be deduced by subtracting the pressure at the altitude at which terminal velocity is attained from the pressure at the altitude at which the parachute is opened. The actual pressure change can be simulated in an altitude chamber at a descent rate of 10,500ft per minute.

The pressure changes encountered during such a descent would require the efficient and proper functioning of the ET to equalize the pressure between the middle ear and the atmosphere. Failure to equalize can cause pain and/or a ruptured eardrum. Freefallers can equalize by simulating chewing, yawning, or by pinching the nose and with the mouth closed attempting to blow air from the mouth (Valsalva Manoeuvre). They can also perform other manoeuvres like Frenzel or Toynbee. Proper training in the use of these is a part of the combat freefall course. The pressure changes would be more at lower altitudes as the changes in atmospheric pressure are more at lower altitudes. The rate of descent at higher altitudes would be more due to rarity of the atmosphere and therefore, less of drag force and an effective higher terminal velocity but would not equal pressure changes at lower altitudes.

The existing protocol is to examine the capacity of the paratrooper to ventilate the middle ear and equalize pressure at a rate of descent of 3000ft/min (from 10,000ft to ground level) as per IAP 4303 [5]. This simulates a maximum of 63-79 mmHg/min pressure change, which is not in accordance with the pressure change experienced during the actual combat freefall. The combat free fall course is a course of 76 days that includes all type of jumps along with theory classes and ground based training [11]. Phase I revealed 44% of the freefallers had congestion following freefall but did not complain of any discomfort or pain. The congestion cleared of within 24 h as all subjects were examined on the subsequent days and were not permitted to jump till the congestion cleared.

In Phase II, the present protocol of 3000ft/min descent rate along with a descent rate of 6000ft/min and 10000ft/min from an altitude of 12,500ft was simulated. Bangalore being at an altitude of 3200ft, simulation of the run was so that, it mimicked descent rates to ground level (12,500ft to ground level at Bangalore in 50 sec which, simulated 10,000ft/min descent from 10000ft to ground level). All subjects cleared the 3000ft/min descent rate ear clearance run without any symptoms or clinical findings. During the 6000ft/min descent rate nine subjects complained of pain and ten complained of some discomfort during or after the run. They were examined after the run and nine subjects had congestion of the tympanic membrane and can be classified as Grade-I according to Teed's classification for middle ear barotrauma. Five of these subjects showed a type-C curve on tympanometry indicating a negative pressure in the middle ear cavity, which is interpreted as an inability to equalize middle ear pressure. The results showed a statistically significant change between 3000ft/min and 6000ft/min rate of descent in respect to the findings of pain (χ^2=7.11; p<0.008), discomfort (χ^2 =8.10; p<0.004) and congestion (χ^2=7.11; p<0.008). Tympanometry findings (χ^2=3.20; p<0.074) were not statistically significant. The subjects were then given a decompression chamber run at a rate of 10,000ft/min. No subjects who had a symptom or sign at 6000ft/min were given this run. Two additional subjects complained of discomfort and congestion was seen in 11 subjects. Tympanometry revealed a negative ear pressure in 4 more subjects. When analyzed a significant difference in congestion (χ^2 =9.09; p<0.003) was seen when compared to the 6000ft/min protocol. No other parameter showed any significant difference. Congestion was not considered as significant in the comparison between 6000ft and 10,000ft/min protocols, as during actual freefall in trained combat freefallers 44% of them showed signs of congestion without any other symptoms and when these paratroopers were reviewed next morning after approximately 24 h this congestion had cleared off in all of them. Pain (χ^2 =7.11; p<0.008), discomfort (χ^2 =10.08; p<0.002), congestion (χ^2 =18.05; p<0.000) and tympanometry (χ^2 =7.11; p<0.008) all were statistically significant when the descent rate of 3000'/min and 10,000'/min were compared. None of the subjects complained or had any signs or symptoms related to the GI tract or maxillofacial sinuses. This clearly signifies that a descent rate of 3000ft/min is not appropriate to assess the pressure equalizing capability of the individual's middle ear. As the actual descent rate are near 10000ft/min it would be ideal to simulate this descent rate as with 3000ft/min a number of individuals who are likely to have a problem during freefall may be missed and this could place an incapacitating situation in the time of war. This is evident from the significant number of subjects who complained of pain and/or discomfort and those who showed signs of congestion and tympanometry findings.

The findings between the descent rates of 6000ft/min and 10000ft/min were not statistically significant except for congestion (χ^2 =9.091; p<0.003) which was seen in an additional 11 subjects. In view of the above findings, a protocol of 10000ft/min should be followed to assess the paratroopers before the combat freefall course. Existing (Hypobaric chambers at Hindon and AFA can simulate only upto 6000ft/min controlled descent), a protocol of 6000ft/min may be a suitable choice and far near reality than 3000ft/min.

USAF follows a similar protocol for freefallers described in Para A4.3 of AFIII – 403 as the type 3 hypobaric chamber flight. The protocol for High Altitude Parachutist Original training, as they refer to it in the chamber, consists of a flight to 35,000ft at 5000ft/min ascent rate. At 35,000ft jumpers use emergency oxygen, which simulates the oxygen bottles that they would use while, performing jump operations [12]. Then begin a rapid decent to 8,000 feet at 10-12,000ft/min simulating freefall (would be similar to a descent rate of 9000ft/min from 9000ft to ground in terms of pressure change if we consider rate of descent as 12,000ft/min from 35,000ft to 8000ft and maximum pressure change from 20,000ft to 8000ft). Once at 8000ft, re-ascend to 25.000ft where the jumpers get their hypoxia symptoms training. After recovery descend to 18,000ft for a visual acuity demo and then continue back to ground level at 5000 fpm. The experienced jumpers receive a refresher flight to 25,000ft. If the students do not complete the training, they cannot attend the Military Freefall School, as it is a requirement to attend the course. The complete protocol lasts 70 min. We in the IAF follow two runs: one for ear clearance and a separate run for Hypoxia indoctrination in which we expose the individual to 30,000ft. Therefore, an ear clearance run with descent rate of 10,000ft/min followed by the hypoxia indoctrination would be similar to this protocol being followed by USAF.

The barometric pressure changes to which the aircrew of a modern military aircraft may be exposed are of different order compared to those experienced by aircrew or passengers aboard a commercial airliner or transport aircraft. Commercial airliners restrict the cabin altitude to between 5000ft-8000ft and the rate of descent does not exceed 300-500ft/min. In military combat aircraft the cabin altitude rises upto 20,000ft and the rate of change of cabin altitude is approximately 1200-2000ft/min in HPT-32, 4000ft/min in Kirans, 6000ft/min in Jaguar & Mirage and 8000ft/min in MiG-21. In steep dives for bombing or emergency descents in explosive decompression the descent rate may near upto 10,000ft/min [13]. RAF had laid down decompression chamber run protocols for fast jet, multi-engine, propeller aircraft and helicopters. The maximum rate of descent followed is for fast jet aircraft in which the aircrew are subjected to a 10,000ft/min descent from 25,000ft to 10,000ft (equal to maximum 7000ft/min descent from 7000ft to ground in terms of pressure) and then 6000ft/min from 10,000ft to ground level. The descent rate of 6000ft/min is applicable in all protocols for fastjet, propeller or helicopter crew. The descent rates in these aircraft as mentioned are of the order of 6000ft- 10000ft/min [6].

Therefore, in view of the findings of the study and the protocols used in the USAF for combat freefallers, a descent rate of 10,000ft/min would be ideal. Keeping in mind the limitation of chambers in the IAF and the insignificant difference in symptoms and tympanometry findings between the 6000ft/min and 10,000'/min descent protocol, a 3000ft/min descent protocol followed by a 6000ft/min descent rate protocol, is acceptable for simulation for ear clearance run in combat freefallers from an altitude of 12,500ft. Even though, the differences in findings of congestion were significant between 6000ft/min and 10,000ft/min descent rate, the congestion seen in the subjects disappeared after 24 h in all the subjects. Congestion was also seen in Phase I of the study in 44% of freefallers, which also disappeared after 24 h and therefore, can be treated as benign. For aircrew of the fighter stream a 6000ft/min descent rate protocol is ideal, considering the rate of descent in instrument descents, steep dives or in case of explosive decompression, as this is the maximum rate of change of pressure they experience in the worst of situations encountered during a flight, even in a fighter. RAF is following a similar protocol.

It is therefore, recommended that, the 'Ear Clearance Run' protocol for combat freefall course as well as for aircrew of the fighter stream, be an ascent to 10,000ft with an ascent and descent rate of 3000ft/min followed by an ascent to 12,500ft at an ascent rate of 3000ft/min and a descent rate of 6000ft/min. The following ear clearance protocol for combat freefall course and training of aircrew of the fighter stream is recommended:-

(a) Firstly, an initial Ear Clearance run from 10,000' to ground level at the rate of 3000'/min, as is being followed as per Para - 3-11-12 of IAP 4303, 3rd Edition 2003.

(b) Secondly, another Ear Clearance run with a descent rate of 6000ft/min from the 12,500ft to ground level.

As and when the capability of the hypobaric chambers are upgraded to a controlled variable descent of 10,000ft/min and the HALO operations in the IAF and Indian Army are revised i.e. freefall is done from 25,000ft-30,000ft as done in other Armed Forces, a third Ear Clearance run, with a descent rate of 10,000ft/min from an altitude of 25,000ft-30,000ft upto 12,500ft and then a descent of 6000ft/min to ground level should be added to the above protocol. The ascent rates to remain 3000ft/min. To simulate a freefall from 25,000ft-30,000ft supplemental oxygen all through the run and a pre-breathing for 45 min is to be used to avoid symptoms of hypoxia and DCS.

Conflict of interest: None

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