【Abstracts】

The 3rd Conference U.S. – Japan Panel on Aerospace, Diving Physiology & Technology and Hyperbaric Medicine (formerly UJNR) Held at Nakatsu Grand Plaza Hotel in Nakatsu Japan on 7–8 November 2008

President Mahito Kawashima M.D., Ph.D.

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Scientific Session A: Diving Technology A1

DEVELOPMENT OF DIVING TECHNOLOGY IN JAPAN BEFORE WWII

Ikeda T[1,2], Mochizuki T[1,3], Kobayashi K[1]
Yanagisawa H[1]
[1]Dept. of Public Health and Environmental Medicine, The Jikei University School of Medicine
[2]Japan Dive Association
[3]Community Health Science Center, Saitama Medical University

Although Japanese made limited contribution to the development of diving technology, looking back to the days before WWII, we can trace our own movements of extending and improving dive capabilities. For examples, ama divers invented innovative underwater goggles free of mask squeeze as early as 1880s. Ogushi mask invented in 1919 was basically a surface supplied dive apparatus although it was sometimes cited as a scuba gear. Unique point is the adoption of a regulator of air supply. Divers bite a lever which regulates the volume of gas supplied into the mask. This reduced the required volume of air and allows both hands free for under water work. Ogushi mask was used for the recovery of gold ingots from the depth of 80m in 1924. Asari mask made in 1937 is another successful diving mask. Small reservoir space was attached on both sides of the mask. This attachment worked as an inside of helmet and the required volume of air supply was almost the half of that in hard hat helmet diving. Also there were several trial pieces of brand new diving technology represented by rebreather and scuba diving though they were not satisfactory for practical use. Interesting is that these efforts and movements were mainly conducted in civilian communities unlike other countries where navies played some important roles.

Scientific Session A: Diving Technology A2

BORING DEEP TUNNELS

R.W. Bill Hamilton, Edmond Kay
Hamilton Research, Ltd., Tarrytown, NY, and DivingDoc PC, Seattle, WA

The process of digging tunnels deep underground has changed in the last three decades, due largely to the Tunnel Boring Machine (TBM). This has revolutionized the compressed air mining and tunneling industry, creating a whole new world. The TBM consists of a circular, rotating, cutting head or face, which may be from 5 to more than 10 metres in diameter; this is pushed forward as it cuts, while a tunnel is cemented behind it. The modern pressure-shielded TBM allows compressed air workers (CAW) to work in a relatively safe one-atmosphere environment behind the face. Occasional excursions (interventions) into the pressurized head space through a man-lock are performed to service the cutter head. These interventions may involve only two or three workers at a time and may last minutes to a few hours, in sharp contrast to the traditional "sand hog" operation where dozens of workers worked shifts as long as could be managed within a normal work day.A fundamental new development is the extensive use of oxygen. Use of oxygen breathing is limited in some jurisdictions, but there is no doubt that oxygen can greatly improve both the speed and the reliability of decompression. Its use requires following well-established safety procedures. TBM depths may exceed the narcotic limits for effective work using air as a breathing gas, so operators may use a trimix of oxygen, helium, and nitrogen. Wide experience with these mixtures in diving is finding its way into tunneling practice. Modern TBM techniques allow work at pressures much greater than those considered normal for traditional methods, so may have to operate under archaic rules and procedures. This may require physiological and medical as well as political expertise to manage. The maximum pressure allowed by the

U.S. OSHA rules is 50 psi, or about 3.5 bar gauge. These techniques are being used in the 22 km, 8 bar Brightwater Project north of Seattle, WA.

Scientific Session A: Diving Technology A3

OPTIONS FOR DIVING ACCIDENT MANAGEMENT IN REMOTE LOCATIONS

William C. Phoel, Ph.D.[1], J. Morgan Wells, Ph. D.[2]
[1]Phoel Associates, Inc. 35 Freeman Court, Toms River, New Jersey, USA, 08753-2613
[2]Undersea Research Foundation, Inc., P. O. Box 696, North, VA, USA, 23128

Research oriented deep diving operations in remote locations require forethought and planning in order to have the capability to efficiently conduct successful diving accident therapy. Remote locations can be arbitrarily defined as those areas beyond the rapid reach of rescue agencies where the injured diver can be extracted and transported to a recompression facility ashore. The therapy of choice is an onsite recompression chamber and associated equipment manned by professional medical and chamber personnel. Modern recompression chambers and associated equipment are now smaller, lighter, and carry smaller footprints than those previously employed. This reduction is due to the use of oxygen concentrators vice bottled oxygen, pneumatic cooling devices vice standard air conditioning units, and smaller chambers no longer requiring large diesel low-pressure compressors. Thus the system no longer requires a large dive support vessel. When an on-site recompression chamber is not available, in-water recompression using oxygen is an alternative and has been used successfully. In-water recompression has its best outcomes when used in warm, clear, calm waters where other divers can monitor the patient. It can also benefit from modern equipment such as the oxygen concentrator that can provide high concentrations of oxygen to the diver undergoing in-water recompression therapy. The least favorable therapy is when it is not wise to place the injured diver back into the water but to treat him/her on the dive vessel using only oxygen and hydration. This therapy has been used successfully for a type two DCS without any residual effects.

Scientific Session A: Diving Technology A4

UNITED STATES NAVY CONTAMINATED WATER DIVING UPDATE

CAPT John W. Murray, MC, USN, LT James Pearson RN, Mr. Ruben Finger, Phoenix International
Naval Sea Systems Command, 1333 Isaac Hull Avenue, SE Stop 1073, Washington Navy Yard, DC 20376-1073, USA

The United States Navy is committed to developing effective general guidance and basic procedures for diving in contaminated water. Contaminated water is defined as water which contains any chemical, biological, or radioactive substance which poses a chronic or acute health risk to exposed personnel. Some degree of contamination and/or pollution is evident in practically every body of water in the world. These contaminants could present a potential health risk to U.S. Navy Divers and may additionally impact mission and operational readiness. An update will be provided on the current U.S. Navy Guidance for Diving in Contaminated Waters, including training materials developed in support of recent demonstrations of decontamination equipment and procedures for contaminated water diving, as well as NAVSEA funded research and development in support of contaminated water diving.

Scientific Session A: Diving Technology A5

CARBON DIOXIDE REMOVAL IN CLOSED ENVIRONMENT ATMOSPHERES

Takatoshi Shoji, Akira Kimura
Kawasaki Shipbuilding Corporation, Submarine Design Department
1-1, Higashikawasaki-cho 3-chome, Chuo-ku, Kobe, 650-8670 Japan

CO_2 removal process is used for life support systems in a submarine and a spacecraft. In other semi-enclosure space, such as aircrafts, office-buildings and rail cars, the cockpit/cabin atmosphere is always clear up by fresh air feed. Recently, the quantity of ventilation air increases year by year, because of high CO_2 concentration on the earth. The increase of ventilation air causes large energy consumption of air-conditioning systems.

The purpose of this study is to apply the CO_2 removal technology to industrial fields for reducing ventilation fresh air and air-conditioning energy.

We studied for an advanced CO_2 removal processes in which adsorption CO_2 is purged by lower temperature hot-air and/or steam. We confirmed adsorption CO_2 was well purged by 60-65 degree C air and/or saturated steam feed in low-pressure atmosphere. Low-temperature purging operations are expected small energy consumption and long durability operation of CO_2 removal systems.

Scientific Session B: Decompression illness B1

DECOMPRESSION ILLNESS IN JAPANESE AMA DIVERS

Hideki Tamaki, Kiyotaka Kohshi, Tatsuya Ishitake, Robert M Wong
Tamaki Hospital, Yamaguchi, Japan, Kurume University School of Medicine,Fukuoka, Japan, Department of Diving and Hyperbaric Medicine, Fremantle Hospital, Australia

Decompression illness (DCI) following repetitive breath-hold dives has been disputed and debated in the medical fields. We present our experience five professional breath-hold divers (Ama) in Japan with DCI after repetitive dives to depths of 10-30 msw. All these 5 Ama divers have neurological events after diving continuously for 2-4 hours and up to 30 times per hour with short surface intervals. All their symptoms are neurological, such as motor weakness, paresthesia, speech disturbance, and/or visual deficit. Many of the symptoms are transient and recover completely within a month. Spinal involvements, which are common in compressed air diving, have not been seen in Ama divers. Their brain MRIs show multiple cerebral infarcts in border or terminal zone areas, and these lesions are considered to be cerebral arterial gas embolism (CAGE). The mechanisms of DCI following breath-hold diving are not clear. We have hypothesized that venous bubbles are tapped in the smallest pulmonary arteries and on repetitive diving, these are compressed and pass through to the arterial side of the circulation. The arterialized bubbles expand during ascend to the surface and they induce CAGE.

Scientific Session B: Decompression illness B2

PREDICTED PROBABILITY AND SEVERITY OF SYMPTOMS IN 100DOCUMENTED CASES OF DECOMPRESSION SICKNESS IN RECREATIONAL DIVING

Petar J. Denoble, Richard D. Vann, Richard Dunford
Divers Alert Network 6 West Colony Place, Peter B. Bennett Center, Durham, NC 27505, USA

Recommended exposure limits in recreational diving are intended to alleviate risk of decompression sickness (DCS). Decompression sickness still occurs but the incidence is low and symptoms are mainly mild although some severe cases occur, too. We examined the relationship between the severity of decompression exposure and severity of symptoms in 100 cases of DCS with documented depth-time profiles. The severity of exposure was calculated using probabilistic decompression models calibrated on experimental dives and expressed as a probability of decompression sickness ($P_{(DCS)}$). In most cases the exposure was within recommended limits. The ($P_{(DCS)}$) varied from between near zero and 8%. There was no significant correlation between the severity of exposure and the severity of symptoms. Cases were compared to 50 cases of DCS acquired in experimental dives and to 50,000 recreational dives with symptom free outcomes. The incidence of DCS in low-risk dives may not be possible to reduce further by controlling the depth-time exposure only.

Scientific Session B: Decompression illness B3

DECOMPRESSION ILLNESS IN A BREATH-HOLD DIVER

Shuji Arakawa, Akinori Minato, Takao Ishitsuka, Hiroshi Kamo*
Department of Cerebrovascular Disease and Orthopedics*, Kyushu Rosai Hospital
1-3-1 Kuzuharatakamatsu, Kokuraminami-ku, Kitakyushu, Fukuoka, 800-0296, Japan

Background: There are little reports of Decompression illness (DCI) occurred in a breath-hold diver.
Case report: A 33-year-old man was referred to our hospital due to dizziness and numbness on his right side. He was a professional breath-hold diver (Ama diver) for 7 years. On February 27, he began to dive to 18 meters of sea water which was at least 3 meters deeper than usual diving depth and sometimes surfaced rapidly. After 2 hours of diving, he felt dizzy, numbness of his right body and chest pain and saw a physician. He smoked two packs of cigaretts per day for 15 years, but he had no history of stroke or other vascular diseases. Neurological examination revealed left abducens nerve palsy, right hemisensory disturbance, right limb ataxia and unsteady gait. MRI of the brain demonstrated hyperintense lesions in right cerebellar hemisphere, pons, right frontal lobe, left thalamus and bilateral corona radiate on diffuiosn-weighted and FLAIR images. Intra- and extra-cranial MR angiographies were normal. Chest CT showed air cysts and ground glass shadows in bilateral upper lung. The patient was diagnosed as DCI. Heparin and free radical scavenger were administerd and daily hyperbaric oxygen treatment was initiated (2.0 atm, 120 min x 12 times). His symptoms improved gradually. On follow-up imaging studies, hyperintens lesions on brain FLAIR images markedly reduced in size and ground glass shadows in the upper lung almost disappeared.
Conclusion: Diving deeply and surfacing quickly can cause DCI even in breath-hold diving. Immediate hyperbaric oxygen treatment was effective.

Scientific Session B: Decompression illness B4

DECOMPRESSION STRESS FOLLOWING MULTI-DAY DIVING

Mochizuki T[1, 2], Ikeda T[2, 3], Kobayashi K[2], Yanagisawa H[2]

[1]Community Health Science Center, Saitama Medical University, SAITAMA

[2]Dept. of Public Health and Environmental Medicine, The Jikei University School of Medicine, TOKYO

[3]Japan Dive Association, TOKYO

Acclimatization to decompression stress in multi-day exposure is reported to occur in caisson and underwater workers. However, as suggested by the term "Friday bends," some of divers feel on the contrary that the risk of decompression sickness increases with successive exposures.

We monitored a series of 29 day-long diving works for the maintenance of an electric power plant. The average depth and bottom time were 24.7 (SD 9.7) m and 37.1 (SD 16.9) minutes, respectively. The average water temperature was 5.3 (SD1.4) degrees centigrade.

Among divers, the subjects were two divers (diver A: 53 y.o., 167cm, 58kg and diver B: 53 y.o., 164cm, 60kg) who were engaged in whole period of the work. As an index of decompression stress, ultrasonic precordial monitoring of circulating bubbles were employed. As an index of work load, the volume of supplied gas to each diver was used.

Circulating bubbles were detected on 17th, 19th and 26th days of the work in diver A and on 26th day in diver B. The supplied gas volume at the depth was as high as 55 litters/minutes in the first six days of diving in diver A, with subsequent decrease to around 35 litters/minutes for the rest of diving period. In diver B, supplied gas volume remained around 24 litters/minutes throughout the diving. We think the acclimatization to decompression does not occur as far as this research of the very limited number of subjects is concerned.

Scientific Session B: Decompression illness B5

NEW TREATMENT SYSTEM FOR DECOMPRESSION ILLNESS USING DUOPLACE CHAMBER IN JAPAN MARITIME SELF- DEFENSE FORCE

Naoaki Isoi[1], Shinya Suzuki[2], Hitoshi Ogawa[3]

[1]Mine Warfare Force Headquarter, Japan Maritime Self-Defense Force, 1-43 Nagaura, Yokosuka, Kanagawa, 237-8515, JAPAN

[2]Division of Environmental Medicine, National Defense Medical College Research Institute, 3-2 Namiki, Tokorozawa, Saitama, 359-8513, JAPAN

[3]Maritime Staff Office, Japan Ministry of Defense, 5-1 Honmura-cho, Ichigaya, Shinjuku-ku, Tokyo, 162-8801, JAPAN

Portable duoplace recompression chamber (PDRC) is equipped in the latest minesweeper coastal (MSC) engaged in mine counter measure missions on Mine Warfare Force, Japan Maritime Self Defense Force (JMSDF). We describe our new recompression system using PDRC in JMSDF.

Immediate recompression at the incident diving site is effective to reduce symptoms due to decompression illness. Underwater explosive ordnance disposal is a major diving activity for mine counter measure operations. Therefore, we have to provide an emergency case with fast recompression on board and transport to the nearest stationary chamber. As an on-site chamber, in JMSDF Mine Warfare Force, every MSC has a portable monoplace chamber, which has some problems on treating for serious decompression illness, and minesweeper tender (MST) has a multiplace recompression chamber. Duoplace chamber is useful to transfer unstable patients to MST or medical facilities and to perform US Navy Treatment Table 5 or 6 when oxygen is available on MSC. PDRC on the MSC has a NATO flange in order to transfer under pressure and connect with multiplace recompression chamber on board. However, multiplace recompression chamber on MST is not equipped with NATO hatch yet.

We are planning how to operate chambers on board and transfer patients under pressure during mine counter measure operations. PDRC on MSC may provide immediate recompression treatment in restricted area where MST is not available. We have to discuss more about to establish the protocol of recompression treatment in JMSDF.

Scientific Session B: Decompression illness B6

A MINI REVIEW OF LONG TERM NEUROLOGICAL DEFICITS IN DIVERS WITHOUT EVIDENCE OF DCS

Peter B. Bennett, Ph.D, D.Sc

Undersea and Hyperbaric Medical Society

Residual disabling signs and symptoms occur in some recreational divers after contracting neurological decompression sickness (DCI). Some studies with MRI also have implied that even without DCI, the presence of hyperintensities of the brain indicates possible damage in the central white matter and basal ganglia, yet another research found no difference from controls. These studies will be discussed to infer that, none the less,

standard recreational diving unless there is neurological DCI, is safe.

Similar concerns have been directed to saturation diving. Again, the information is equivocal. Most of the data inferring memory problems in attention and decompression have come from Norwegian research. Three symposia held in Norway in 1983, 1993, and 2005 did not receive similar support from deep saturation diving research in the USA, France, Germany, or UK that there are any changes in the quality of life of the divers.

Never the less, it may be concluded this issue remains controversial and more data is required. DCI may result in long term pathology and injury. Saturation diving does not appear to cause long term neuropsychological injury, but petroleum products may be responsible for some of the reported problems.

Among other factors, saturation diving may result in dysbaric necrosis of bone (DON) and stroke like symptoms can be seen in commercial fisherman divers. Divers may also experience high frequency hearing loss from noise in chambers and helmets. Standard recreational diving however is believed to be safe from long term effects.

Luncheon Seminar 1 **S1**

SAFER ASCENT CONCEPTS FOR THE RECREATIONAL DIVER

Peter B. Bennett, Ph.D, D.Sc
Undersea and Hyperbaric Medical Society

The decompression sickness (DCS) risk after ascent for recreational divers is primarily due to neurological signs and symptoms. The risk is low but may be affected by the depth of dive, dehydration, obesity, age, water temperature, degree of exertion, etc.

Today, there are many ascent tables and computers using different algorithms, but which is safest? However, factors like exercise, temperature, oxygen, and safety stops may help to make ascents safer.

Recently, for example, exercise 24 hours or even 2 hours before a dive was shown to significantly reduce vascular bubbles post dive. Exercise during a dive leads to increased risk of DCS while exercise during ascent appears to decrease risk, but exercise after the dive increases the risk of DCS.

If a diver is warm during the dive and then becomes cold for the ascent, the risk of DCS is increased, but if the diver is cold during the dive and warm on the ascent, the risk is lower.

Oxygen can be used by divers to mitigate DCS in many ways. In recreational divers it is commonly using Nitrox mixtures. The increased oxygen in Nitrox 36 or Nitrox 32 provides for longer bottom times. For safer ascents, the diver should dive Nitrox but ascend using an air table.

A shallow "safety stop" at about 5m (15 ft.) for 3 to 5 minutes significantly decreases vascular bubbles and is now widely used by divers. Recent research has shown also a deep " safety stop" for 2 ½ minutes at half the absolute depth can also significantly reduce vascular bubbles post dive at 25m (82 ft.). Whether this also will be the same for all recreational divers, depth remains to be established as does it if will reduce DCS.

Scientific Session C: Diving Physiology 1 **C1**

PHYSIOLOGICAL RESEARCH AT JAPAN MARINE SCIENCE AND TECHNOLOGY CENTER (JAMSTEC)

Keizo Shiraki
UOEH, 1-1 Iseigaoka, Yahatanishiku, Kitakyushu, 807-8555, Japan

The purpose of the present presentation is to give an overview of the extensive human physiological studies related to diving, which have been conducted at JAMSTEC. The first cooperative saturation diving experiments (Seatopia study) was carried out in 1972 between JAMSTEC and the University of Hawaii. The major physiological questions in the diving experiments have been directed at evaluating the effect of hyperbaria on cardiovascular function, energy metabolism and thermal regulation, body fluid balance and, changes in central nervous system function. An important effect of prolonged exposure to a hyperbaric environment is the development of a sustained diuresis in humans. In the Seadragon IVexperiment (1979), a seven-day saturation dive at 31 ATA, the characteristics of hyperbaric diuresis and nocturia were examined in detail. New Seatopia experiment was undertaken in order to study human responses to a seven-day continuous exposure to a dry and wet helium-oxygen environment at 31 ATA (1985). Unique results of the experiment were obtained including; (1) the diuresis was mostly attributed to an increased nocturnal urine volume (nocturia), (2) the hyperbaric diuresis was not related to the chamber temperature, (3) alteration of circadian rhythms of body temperature, (4) deconditioning of cardiovascular system, and (5) topographic EEG analysis revealed a correlation between the depth of the dive and an increase in frontal midline theta wave activity. The last series of human experiment at JAMSTEC was the "Scientist-in- the-Sea" experiment at 4 ATA saturation dive (1997-1999), where a pressure-related unique result was obtained in the sensitivity of the adrenoreceptors. by administrating the pharmacological agonists of the receptors. It is evident

from these studies that many physiological changes occur in a hyperbaric environment which are not clearly understood. Furthermore, the development of research vehicles, which are capable of diving to much greater depths, underscores the need for continued studies of man's ability to survive and adapt under these conditions.

Scientific Session C: Diving Physiology 1 C2

UPDATE ON DECOMPRESSION: DEEP STOPS

R.W. Bill Hamilton
Hamilton Research, Ltd., 80 Grove Street, Tarrytown, NY 10591 USA

As technical diving has been developing, divers have been experimenting with the use of deeper stops. How beneficial deep stops are and how best to do them is not at all settled. Two recent workshops have addressed technical diving and the deep stop. These were the Technical Diving Workshop sponsored by DAN in 2008 January, and a workshop dedicated solely to deep stops held with the Undersea and Hyperbaric Medical Society in 2008 June. Technical diving involves complex management of breathing gases to deal with narcosis and oxygen toxicity, and divers must haveamong other thingsappropriate decompression tables, adequate thermal protection, organized surface support, and be highly trained and dedicated. Haldane-type tables generally have the diver ascend fairly rapidly until near the surface, then ascend more gradually to the surface. Various schools of decompression practice have shown that decompression can often be improved by slowing down the initial ascent or putting in some deeper stops. Haldanian algorithms require extra time after deep stops, but some algorithms, one being RGBM, reduce total decompression time when deep stops are used. One commercial-type 150 msw profile showed a remarkably reduced decompression time after a deep stop but the method did not tolerate deviations. How best to do deep stops and how to assess and understand the benefits is not well established. There is no doubt that there is something to this idea. One viewpoint is that deep stops are more effective in reducing neurological DCS than pain-only bends. One extensive set of tests by the US Navy got more decompression sickness (DCS) after dives with deep stops than after those using traditional profiles. The consensus conclusion of the Deep Stops Workshop is that there is no conclusion at this time. In any case we need to get more data, and DAN' s Project Dive Exploration is working to accomplish this.

Scientific Session C: Diving Physiology 1 C3

PHYSIOLOGY OF BREATH-HOLD DIVERS

Frédéric Lemaître, Ingrid Castres, Didier Chollet, Claire Tourny-Chollet
Centre d'études des transformations des Activités Physiques et Sportives (CETAPS, EA 3832), Faculté des Sciences du Sport, Université de Rouen, Boulevard Siegfried, 76130 Mont-Saint-Aignan, France

The aim of this presentation was to resume the specific effect of breath-holding (apnea) physiology and the consequence of such apnea training. The diving response includes cardiovascular adjustments known to decrease oxygen uptake and thus prolong the apnea duration. This diving response has several components: mechanical, chemical, dynamical, outside factors (temperature, training, posture, altitude etc..), psychological, all affecting the apnea duration. Several apnea breaking points exists and also can modify this apnea duration. Finally this response can be change during diving in breath-hold divers improving diving capacity but increasing underwater risks (syncope). Higher lung function, stronger bradycardia, lower CO_2 chemosensibility, improved diving psychology, a better oxygen-conservation, lower lactatemia, and free radical production have been found in trained breath-hold divers. Such adaptations may be interesting in other sports.

Scientific Session C: Diving Physiology 1 C4

WHY CAN THE WHALE DIVE DEEPLY? − HISTOLOGICAL CHARACTERISTICS −

Tatsuo Shimada, Takashi Yamaguchi, Hiromi Kai, Yoshihara Takaki,
Masahiro Segawa, Sachiko Kato, Hiroaki Kawazato, Hajime Ishikawa
Faculty of Medicine, Oita University, 1-1 Idaigaoka, Hasama, Yufu-city, Oita, 879-5593 Japan. The Institute of Cetacean Research, 4-5 Toyomi, Chuo-ku, Tokyo, 104-0055 Japan

The whale, which is a typical aquatic mammal, is able to dive deeply for a long time. It is a mater of common wonder. The body of the whale appears to show specific histological structures considerably different from the human body. We were particularly interested in structures of the skin, skeletal muscle, heart, lung and brain, because the whale was come under water pressure and coldness to dive deeply. In this study, Antarctic minke whales (Balaenoptera bonaerensis) were used, and small tissue blocks were prepared to examine by means of light and electron microscopy. The present materials were given from whales which were caught by reason of

"2005/6 the Second Phase of Japanese Whale Research Program under the Special Permit in the Antarctic."
Although the left ventricular wall was thicker than right one, the ventricle of the whale heart was certainly heart-shaped. The ventricular myocardium of the whale was similar in ultrastructure to the human myocardium. However, Purkinje cells, which were terminal ramifications of the cardiac conduction system, were considerably large in size as compared with human cells. The whale lunge was occupied by a limitless number of alveoli, and was also characterized by the presence of a lot of hyaline cartilages as well as elastic fibers. The skeletal muscle belonged to the red muscle type with numerous mitochondria in addition to myofibrils. The skin was very thick. The epidermis consisted of the kelatinized stratified squamous epithelium containing a lot of melanin granules. Dermal papillae with blood capillaries were densely distributed. The subcutaneous fat layer was very thick, and each cluster of fat cells was surrounded by thick collagen septa. In addition, nerve cells in the cerebral cortex and spinal cord were smaller in number, while Purkinje cells in the cerebellum were large in number like human being.
Thus, the whale body demonstrated structural and functional adaptations to an aquatic environment.

Scientific Session C: Diving Physiology 1 C5

WOMEN IN DIVING: A PERSPECTIVE AFTER 20 YEARS

Caroline E. Fife, MD, Marguerite St. Leger Dowse, William P. Fife, PhD
The University of Texas Health Science Center, Houston, Department of Medicine, Division of Cardiology and the Memorial Hermann Center for Hyperbaric Medicine;
The Diving Diseases Research Centre (DDRC), Plymouth, England; Texas A&MUniversity Professor Emeritus.

Background: In Western countries, women represent from one third to one half of recreational and scientific divers, and a small but growing proportion of military and commercial divers. A variety of concerns have been raised in the past decades regarding possible gender differences in susceptibility to DCI and diving habits.
Methods: Since 1993, a collaborative effort among scientists from the U.S. and Britain, published by the DDRC, has allowed analysis of large volumes of field data.
Results: Over four years, 2250 divers responded, 47% of whom were women. Of the 458,827 dives reported, 310% were by women. There appear to be gender differences in diving habits with females reporting fewer dives per year, fewer days of repetitive diving, and being less likely to perform decompression diving although they may also be less likely to perform a "safety stop." When the level of experience was taken into account in this study group, the estimated rate of DCS in men was 2.60 times greater than for women.

Scientific Session D: Diving Physiology 2 D1

DIVERS' SWIMMING ENDURANCE IS ENHANCED BY RESPIRATORY MUSCLE TRAINING, A REVIEW

Claes E.G. Lundgren, MD, PhD and David R. Pendergast, Ed.D.
CRESE, School of Medicine and Biomedical Sciences, University at Buffalo, (SUNY), 124 Sherman Hall, Buffalo, New York 14214, USA

When divers swim at an intensity requiring an oxygen uptake of 70-85% of maximal VO_2 their endurance is limited by respiratory muscle fatigue. We have found that specific training of those muscles can enhance divers' swimming endurance. Data from four studies with several coworkers at CRESE will be cited. Respiratory muscle training (RMT) enhances endurance during terrestrial exertion such as bicycling and running and we hypothesized that RMT would be particularly beneficial for physical activities that place severe demands on the respiration. Accordingly, we studied the effects on divers' swimming endurance at depth employing two types of RMT: Resistance RMT (RRMT) and Endurance RMT (ERMT). Training at home for 30 min the eupneic subjects took a vital capacity breath every 30 sec against spring loaded inspiratory and expiratory valves requiring pressures ≥ ～ 50 cmH_2O. This was done once a day three to five days/ week for four weeks. Performing ERMT, resting subjects breathed at a frequency and tidal volume generating a total ventilation of 80-100L/min, paced to be barely sustainable for 30 min (CO_2 admixture to inhaled gas prevented hypocapnia). The same caledar schedule was used as for RRMT. RMT' s enhancement of respiratory muscle performance was demonstrated as increased maximal inspiratory and expiratory pressures and ability to sustain a high isocapnic minute-ventilation. Effects of RMT on swimming endurance were: after RRMT the subjects' swimming time before exhaustion increased by 66% at 1.2m of depth and by 33% at the surface and after ERMT by 26% and 38% respectively while, at 17.7m, the swimming time after RRMT increased 60% and at 36m by 87%. These improvements were coupled with reduced work of breathing during swims and could be maintained for months with only

two training sessions/week. Conclusion: By reducing respiratory muscle fatigue RMT substantially enhances divers' productivity and safety.

Scientific Session D: Diving Physiology 2 D2

SYSTEMIC AND PULMONARY HEMODYNAMICS AND THE EFFECT OF HEAD TEMPERATURE DURING PRONE EXERCISE IN COLD AND WARM WATER

Moon RE, Wester TE, Cherry AD, Pollock NW, Freiberger JJ, Natoli MJ, Schinazi EA, Doar PO, Boso AE, Alford EL, Walker AJ, Uguccioni DM, Kernagis
Center for Hyperbaric Medicine & Environmental Physiology, Duke University Medical Center, Durham, NC 27710, USA

Pulmonary and Immersion pulmonary edema (IPE) is the accumulation of water in the lungs of swimmers and divers, causing cough, shortness of breath and reduced blood oxygen levels. It usually requires oxygen and often diuretics. It occurs in both military and civilian swimmers or divers during heavy exertion, most commonly in cold water. IPE was formerly believed to be rare, but it has been reported that in an open ocean training exercise as many as 1.8% of trainees experience the condition. IPE generally resolves completely in less than a day, but it can be fatal. IPE can recur in some individuals. The cause of IPE is not known, however it is believed to be caused by high pressure within pulmonary vessels (pulmonary artery and capillaries). Immersion in water is known to increase pulmonary vascular pressures. Exposure of the head alone to cold is also believed to increase both systemic and pulmonary arterial pressures (diving reflex). This study was performed to examine the role of the diving reflex in the pathogenesis of IPE, and whether improved head insulation might reduce pulmonary vascular pressures during cold water diving. After institutional approval and informed consent, we studied 10 normal volunteers during immersed rest and prone exercise in whom water temperature surrounding the head and the body could be adjusted independently. Water temperature was either cold (18-20℃) or warm (29-31℃). Mean arterial pressure (MAP), central venous pressure (CVP), mean pulmonary artery pressure (PAP), pulmonary artery wedge pressure (PAWP), heart rate, ventilation, oxygen consumption and cardiac output were measured under each condition. Cold water surrounding the body significantly increased MAP, CVP, PAP and PAWP regardless of the temperature of the water bathing the head. We conclude that when diving in cold water, increased thermal insulation of the head alone is unlikely to prevent IPE.

Scientific Session D: Diving Physiology 2 D3

STUDY OF EEG AND SLEEP DURING HIGH ALTITUDE DIVING

Shi Zhongyuan, Zhang Yanmeng, Huang Xin Chun
Institute of Underwater Technology, Shanghai Jiao Tong University, China

This paper report on the changes of the EEG and sleep of human during simulated high altitude diving experiment. The simulated dive experiments were conducted at the high altitude of 4,500 meters and 5,000 meters. The high & low pressure chamber-complex was used, and 15 professional divers participated in the experiment. The divers were stayed at the altitude of 4,500 and 5,000 meters for 7–9 days. Totally 85 persons-times of dives to the depths of 30–50 meters were operated; they stayed under the water for 30–90 minutes while processing physical activities. During the experiment, we studied the EEG and sleep of the divers. We have recorded the EEG of divers at the sea level as the control, the EEG when he was exposed to high altitude, and the EEG when he was diving, and also analyzed the power spectrum. It can be seen that, when the divers ascended from the sea level to the altitude of 5000 meters, the percent integral values of δ wave was increased significantly in comparison with that at the sea level ($P<0.01$) α wave reduced, and β_1 and β_2 waves increased markedly. The results are follows: sleep disturbances occurred during exposure to high altitude area, such as increases in waking stage, number of arousal times, breathing frequency, heart rate and decreases in deep stage and RME at all night. When the time of exposure to high altitude prolonged or after diving operation there was recovery trend to control value at sea level in all sleep physiological indices. Periodic respiration which can affect hypoxia in the body was shown in the subjects during exposure to high altitude. After diving activities the EEG and sleep had improved.

Scientific Session D: Diving Physiology 2 D4

THEINFLUENCE OF N_2-O_2, He-O_2 AND He-N_2-O_2 SATURATION DIVING ON ELECTROENCEPHALOGRAM OF HUMAN BODIES

Shi Zhongyuan, Zhang Yanmeng, Huang Xin Chun
Institute of Underwater Technology, Shanghai Jiao Tong University, China

This paper reports the changes of the EEG of human bodies during saturation exposure at different depths to different mixed gases. The results of the research show that the most obvious on EEG was the appearance of

diffused slow waves, usually theta waves of 4-7 times/s, and delta waves of 2-3 times/s within individual subjects. The EEG changes at 50m were more obvious than those at 36.5m. With the prolonging of time under high pressure, the EEG had some improvements, for instance, the slow waves decreased and the alpha waves increased. There was a certain relationship between these changes and the symptoms which appeared in the human body. The chief factor of the EEG changes is due to the effect of nitrogen narcosis during the oxygen-nitrogen diving experiment. In addition, carbon dioxide retention under the high pressure is also a factor of the EEG changes, because repeated inhaling of CO_2-dense mixtures could aggravate the EEG changes and the reduction of carbon dioxide in humans by hyperventilation could improve abnormal EEGs. The main changes of the EEG during the helium-oxygen exposure at 302m were the increase of theta waves, and even of delta waves, the decrease in alpha rhythm and the decline of amplitude of alpha waves. Increased theta index and decreased alpha index could be seen at the depth of 302m. Under any of the above-mentioned pressure conditions when slow waves characteristic of abnormal changes appeared in the EEGs, the EEGs could be temporarily improved by photic stimulation, i.e. slow waves disappeared and alpha waves reappeared. When photic stimulation was over, alpha waves disappeared and slow waves reappeared. It was indicated that abnormal changes of the EEG under high pressure were a kind of temporary and reversible changes of the brain function. The result of EEG recording during He-N_2-O_2 mixture at 300m was showing that the EEG changes of increase of theta activities and decrease of alpha activities are similar to those found with other respiratory mixtures. On the other hand, the other symptoms of high pressure neurological syndrome (HPNS) were clearly improved for the same 300m depths. Thus, neurologic symptoms (tremor, dysmetria, drowsiness) are nonexistent, and the performances during psychometric tests remain similar to those of the surface. Nitrogen with its narcotic potency, suppresses some symptoms of HPNS for deep diving.

Scientific Session D: Diving Physiology 2 D5

PITFALLS IN THE INTERPRETATION OF URINARY EXCRETION OF PEPTIDE HORMONES IN HYPERBARIC STUDIES

John R. Claybaugh
Department of Clinical Investigation, Tripler Army Medical Center, Tripler AMC, Hawaii, 96859-5000, USA

Measurement of the urinary excretion of hormones has been an important tool in the assessment of physiological responses of humans to the hyperbaric environment since the earliest reports nearly four decades ago. The kidney concentrates filterable substances that are not reabsorbed by the nephron about 100 fold. Given that hormones may circulate in plasma at femptomolar concentrations, this enhances assay detection. In addition, urine is an ultrafiltrate that may require no extraction before assay. Urine is formed over periods of time and should provide an integrated average of the peaks and valleys of normally fluctuating plasma levels. Despite these advantages, urinary excretion of hormones may not accurately reflect an integrated pattern of the plasma values. First, the assumption of complete filterability is often in error because hormones may be bound to plasma proteins or may be only partially filterable. Secondly the kidney is a site of metabolism for the hormones, for example vasopressin (VP) and atrial natriuretic peptide (ANP). That is, the filtered hormone is altered while in passage through the nephron, making the urine excretion underestimate the events in the plasma. Thirdly, most commercially available assays are a type of immunoassays. The antisera, whether monoclonal or not, will be primarily directed at one portion of the hormone molecule which may or may not be altered by metabolic breakdown of the molecule. Lastly, some hormones have a great capacity for release increasing plasma levels to 1000 fold the normal levels followed within minutes by restoration to normal levels. An event lasting only minutes can influence hormone detected in the urine collected over hours. Therefore, both urinary and plasma hormone values are important and should be validated against each other. The hyperbaric physiology literature has inconsistencies that have been resolved by this validation and some yet to be resolved.

Scientific Session D: Diving Physiology 2 D6

HEART RATE VARIABILITY IN ELITE BREATH-HOLD DIVERS

Frédéric Lemaître, Ingrid Castres, Didier Chollet, Claire Tourny-Chollet
Centre d'études des transformations des Activités Physiques et Sportives (CETAPS, EA 3832), Faculté des Sciences du Sport, Université de Rouen, Boulevard Siegfried, 76130 Mont-Saint-Aignan, France

The diving response includes cardiovascular adjustments known to decrease oxygen uptake and thus prolong the apnea duration. As this diving response is in part characterized by a pronounced decrease in heart rate (HR), it is thought to be vagally mediated. In five

professional breath-hold divers (BHDs) and five less trained controls (CTL), we investigated whether the diving response is associated with an increase in the root mean square successive difference of the R-R intervals (RMSSD), a time-domain heart rate variability (HRV) index. HR behaviour and arterial oxygen saturation (SaO_2) were continuously recorded during one maximal apnea. Short-term changes in SaO_2, HR and RMSSD were calculated over the complete apnea duration. BHDs presented bi-phasic HR kinetics, with two HR decreases. The second HR decrease, which was concomitant to the pronounced SaO_2 decrease, was also simultaneous to a marked increase in RMSSD. CTL showed only one HR decrease, which appeared before the concomitant SaO_2 and RMSSD changes. When all subject data were combined, arterial desaturation was positively correlated with total apnea time ($r=0.87$, $p<0.01$). This study indicates that baroreflex stimulation and hypoxia may be involved in the bi-phasic HR response of BHDs and thus in their longer apnea duration.

Scientific Session E: Osteonecrosis E1

STUDY OF DYSBARIC OSTEONECROSIS IN UW SHEEP DISSUB TRIALS AFTER OXYGEN PRE-BREATHES BEFORE DROPOUT DECOMPRESSION

Sobakin AS[1], Lehner CE[1], Dueland RT[2], Wilson MA[3], Gendron-Fitzpatrick AP[4], Eldridge MW[1]
[1]Dept. of Pediatrics
[2]Dept. of Surgical Sciences
[3]Dept. of Radiology UW Hospital and Clinics
[4]Comparative Pathology Lab, Research Animal Resources Center, University of Wisconsin-Madison, 2115 Observatory Drive, Madison, WI, 53706 USA.

INTRODUCTION: Prolonged exposure of humans and animals to increased pressure as in a disabled submarine (DISSUB) can saturate the body' s tissues with dissolved N_2 if compressed air is breathed. Decompression-induced bubble formation in the long bone marrow cavity may lead to a bone compartment syndrome resulting in bone ischemia and necrosis. We tested oxygen pre-breathes in sheep for their use in preventing dysbaric osteonecrosis (DON) and in minimizing lethal outcomes from decompression illness.

MATERIALS AND METHODS: Sixteen adult female sheep (90 ± 14 SD kg) underwent dry chamber air exposure at 60 fsw (2.79 atm abs) for 24 hours. Sheep were divided into four groups. The first group was treated for 15-min with an oxygen (88-92%) pre-breathe before "dropout" decompression (ascent) to surface pressure at 30 feet/min (0.9 atm/min); the second group for 1-hour O_2 ; and the third group for 2-hours; and the fourth group, a " control," was not given O_2 and breathed only air. One month later, ^{99m}Tc-methylene diphosphonate (MDP) bone scans of radii and tibiae were used to monitor for "hot spots" of remodeling DON lesions. Alizarin complexone fluorochrome was injected IV to visualize DON repair when sheep underwent necropsy to observe potential DON pathology.

RESULTS: Ten sheep exposed to O_2 survived the decompression; all 4 sheep breathing only air died of the chokes. Four sheep which underwent 2-h oxygen pre-breathes survived and developed DON. Gross pathology confirmed new bone remodeling repair of DON in bone-scan " hot spots."

CONCLUSION: This study indicated that 2-h O_2 pre-breathing can reduce the induction of DON in the UW sheep model of the decompressed human and enhance dropout survival.

Scientific Session E: Osteonecrosis E2

OXYGEN DECOMPRESSION MAY PREVENT DYSBARIC OSTEONECROSIS IN COMPRESSED AIR TUNNELLING

Dr. LI Chi Tang Ronson
3903Rm Metroplaza Tower II, 223 Hing Fong Road, Kwai Fong, N.T. Hong Kong

Dysbaric osteonecrosis (DON) comprises necrotic lesions in the fatty marrowcontaining shafts of the long bones as well as the ball and socket joints. The fundamental causes are still in question and the illness remains a significant health hazard. Recent research in animal and human found that intravascular air bubbles triggered coagulation abnormality is an important factor in its pathogenesis. While, genetic factors may also play a role in some potential candidate in DON. 1-3

The technique of hyperbaric oxygen as oxygen decompression has recently been applied in two compressed air tunnelling projects in Hong Kong during the past few years. As results, two groups of compressed air workers had undergone at least two sets of medical examination with full long bone X-ray examinations. Ninetyseven (n=97) and seventy-six (n=76) of these workers been followed over four to six years respectively. We do not found any evidence of dysbaric osteonecrosis in their radiographs examination. Such a finding may suggest that oxygen decompression not only reduce bubbles load and decompression illness, it may also prevent disabling dysbaric osteonecrosis in future especially when compressed air tunnelling using Tunnel Boring Machine (TBM) with shorter compressed air exposure and swallow working depth.

Scientific Session E: Osteonecrosis E3

A CASE OF DYSBARIC OSTEONECROSIS OF THE HUMERAL HEAD —HISTOPATHOLOGICAL ANALYSIS OF PREPARED UNDECALCIFIED BONE SECTIONS—

Makoto Sasaki[1], Semba Ichiro[2], Mahito Kawashima[1], Hiroaki Tamura[1], Ikuhumi Nagayoshi[1], Motoo Kitano[3]
[1]Kawashima Orthopaedic Hospital
[2]Kagoshima University Graduate School of Medical and Dental Sciences, Department of Oncology , Field of Oral Pathology
[3]Department of Medical Sciences and Clinical Pathology, Nakatsu Municipal Hospital

A rare case of dysbaric osteonecrosis (DON) of the humeral head is reported. A 32-year-old Japanese diving fisherman suffered severe clinical symptoms such as pain and restriction of motion of his right shoulder. DON was diagnosed. The articular surface of the humeral head was depressed on radiological and arthroscopic examinations. As conservative treatments for the disorder were not successful, the humeral head was totally removed and replaced by prosthesis. Undecalcified slide preparations were made of the removed humeral head block and examined histopathologically. The depressed region of the specimen showed necrotic changes and repair processes. In the depressed articular surface layer, there was marked production of fibrous cartilaginous tissue. In the subchondral layer, granulation tissue with fibrosis, fatty necrosis and a mixture of necrotic and newly formed bone trabeculae were observed.
These findings provide information helpful for an understanding of the aetiology and pathogenesis of DON. They may also lead to better treatments for DON of the humeral head.

Scientific Session E: Osteonecrosis E4

Hip Resurfacing for Dysbaric Osteonecrosis

Masayuki Kawashima, Ikufumi Nagayoshi, Hiroaki Tamura, Makoto Sasaki, Mahito Kawashima
Kawashima Orthopedic Hospital, 14-1 Miyabu Nakatsu city, Oita pref., Japan 871-0012

Dysbaric osteonecrosis (DON) is frequently found in upper humerus and upper femur among divers and caisson workers. DON of upper femur causes the collapse of the femoral head, and develops into osteoarthritis(OA) of the hip joint with pain and restriction of activity of daily life. If once collapse takes place, progression of destruction is usually relentless, and surgical methods are indispensable. Operations for DON of the femoral head are divided into three groups; (1)varus trochanteric osteotomy, (2)transtrochanteric anterior rotational osteotomy (ARO), and (3)prosthetic femoral head replacement arthroplasty. Prosthetic replacement is rarely indicated as the initial surgical treatment in the young and early middle-aged patients. Therefore osteotomy with the transposition of the weight-bearing portion is often chosen even for the young patients with advanced necrosis of the femoral head. However, the area of DON is generally larger than that of idiopathic necrosis, and the clinical results of osteotomy was often poor because of shortening of leg length or severe progression of collapse after surgical treatment. Some patients who had severe progression of collapse after osteotomy require arthroplasty.
Hip resurfacing has been introduced as an alternative to standard total hip arthroplasty, especially for young and active patients. Possible advantages include greater hip joint stability, bone preservation, and decreased osteolysis. Three cases of DON who were performed hip resurfacing at Kawashima Orthopaedic Hospital are presented. A 37-year-old man, who is a diving fisherman, underwent ARO on the left hip. However, progressive collapse in newly created weight-bearing area occurred and pain increased. After two years the operation, cup arthroplasty was done. A 58-year-old man and a 60-year-old man, who engaged in caisson work using aqualung, underwent metal on metal hip resurfacing for the first surgical treatment.

Scientific Session F F1

AEROSINUSITIS ; EXPERIENCE OF TWOCAS ESFFIGHTER PILOTS;

Yasuyuki Yoshida[1], Rika Ide[2], Teruhiro Nakada[3]
[1]Department of ENT, Chiba Tokushuhkai Hospital
[2]Department of ENT, Eiju General Hospital
[3]Department of Urology, Yotsukaidou Tokushuhkai Hospital

Aerosinusitis is not a rare entity of disease in the clinical practice of ENT field; some reports have already been seen of the civil aviation, however, in Japan, few reports have been made about aerosinusitis in the fighter pilots; We report here our experience of two cases of this condition, occurred in the fighter pilots of the Japan Air Self Defense Force;
Case 1: 30-year-old pilot of the F-4EJ interceptor, complaining of the bi-lateral maxillary pain during landing approach; bilateral polysinectomy was done and he returned to the defense service.
Case 2: 39-year-old pilot of the F-15 interceptor, complaining of the uni-lateral maxillary pain,rt. during

landing approach; right polysinectomy was done and he returned to the defense service, too ;
It was already known, that the barometric change caused ear or sinus pain, even in the 18th Century; in the 19th century, report was made about the sinus tyouble by positive barometric change in the caisson work, such as the paper made by Paul Bert in France; and in the 20th Century, as the aircraft development, decrease of air pressure by altitude caused troubles, known as aviation otitis or sinusitis, especially with the use of Jet Propulsion, which promote the aircraft performance specutacullary. During the Pacific War, with the introduction of high performance aircraft, incidence of sinus pain was increased and named as Aerosinusitis by Paul Campbell, in his Paper, 1942;
We discuss in this report of Imaging Diagnosis, surgical findings and inappropriate aircraft pressurization, with the comparison with passenger airplanes, as the cause of mechanism of aerosinusitis.

Scientific Session F **F2**

USE OF ANALOGS IN THE CONSTELLATION PROGRAM

Crosson, Dudley
Delta P, PO Box 8311, Port St. Lucie, FL 34985-8311, USA

The Constellation Program is a national program led and coordinated by NASA through its Exploration Systems Missions Directorate (ESMD) that has the goal of the scope of human spaceflight and exploration from Earth's Moon to Mars and beyond. Much additional research is needed to provide data to guide the design of systems that can protect and sustain human crews during long, hazardous space voyages and stays on the Lunar, Martian and/or asteroid surfaces. Current human rated flight vehicles, including the International Space Station as well as the Space Shuttle, are inadequate to support the scale and time constraints of a research program on the effects of long duration spaceflight on both humans and human support systems needed to develop system design requirements for the Constellation Program.
Alternatives involve studies carried out in analog environments on Earthenvironments which simulate some aspects of spaceflight or related aspects, such as EVA tasks, isolation, technology development, micro-community environments, physical and physiological stress, and a requirement to remain confined for protection from a hostile environment while performing significant scientific and engineering tasks. Antarctic bases and undersea habitats are well-known examples of high fidelity environments for long duration spaceflight. NASA's ESMD, has provided support to various analogs as well as develop new opportunities.
This paper analyzes and discusses the uses of analog research in developing data to assist in designing systems for the space environment or for that found on the surfaces of the Moon or Mars. It sets parameters to a variety of potential analog environments.

Scientific Session F **F3**

THE CHANGES OF OXIDATIVE STRESS DURING MT. FUJI CLIMBING MEASURED BY FREE RADICAL ANALYTICAL SYSTEM

Rika Ide[1], Yasuyuki Yoshida[2], Fumiyuki Goto[3, 4], Sho Kanzaki[4], Hideyuki Saito[4], Kaoru Ogawa[4]
[1]Eiju General Hospital, Department of Otorhinolaryngology
[2]Chiba Tokushuhkai Hospital, Department of Otorhinolaryngology
[3]Hino Municipal Hospital, Department of Otorhinolaryngology
[4]School of Medicine, Keio University, Department of Otorhinolaryngology

It is known that Acute Mountain Sickness (AMS) cause to increase free radical activity and oxidative stress. Our study investigated serum diacron-reactive oxygen metabolites (d-ROM) and biological antioxidant potential (BAP) to assess the levels of oxidative stress during Mt. Fuji climbing.
Subjects and methods: We performed the measurement of serum d-ROM and BAP in five healthy subjects (male 2, female 3). In addition to these biomarkers, we measured SpO2 (percutaneous measurement of the arterial oxygen saturation) and pulse rate using a pulse oximeter. AMS symptom was checked using AMS score (Lake Louise Acute Mountain Sickness scoring System).
Results: It showed that BAP/d-ROM correct ratio were more than 1.0. SpO2 were statistically significant decreased and pulse rate were statistically significant increased during mountain climbing. ($*P < 0.05$) There was none who AMS score was more than 5.0.
Conclusion: Our study showed that BAP/d-ROM correct ratio after reached the summit were increased. It may be that intensity of exercise caused to increased BAP value and generation of hydroxyl radical is decrease. We are suggested the ability which a proper intensity of climbing act to prevent mechanism for oxidative stress. Oxidative stress measurement may be applied the objective evaluation for physical conditioning in climbing and give the aid for prevention of AMS.

Scientific Session F **F4**

THE ORGAN PRESERVATION WITH CARBON MONOXIDE MIXTURE GAS UNDER THE HYPERBARIC ENVIRONMENT OF 7ATA, RESU-SCITATION AND HETEROTOPIC TRANSPLANTATION OF AN ISOLATED RAT HEART

Kunihiro Seki, Yu Yoshida, Naoyuki Hatayama
Faculty of Science, Kanagawa University, Japan

We succeeded in an experiment in which tardigrades were desiccated using perfluorocarbon (PFC), an inert fluid that has been used in liquid breathing and as artificial blood for mammals since about the 1960s, and then they were exposed to high pressure at 600MPa for resuscitation. We decided to work on an experiment to preserve an isolated mammal organ by immersing it in this desiccated PFC. It was thus demonstrated that after an isolated rat heart was dry-preserved for 72 hours in an environment with 400hPa of partially pressure CO_2 within a hyperbaric environment compressed at 2000hPa and then was resuscitated, it could be heterotopically transplanted into a recipient rat, and the reproducibility thereof was verified. After an isolated heart of the donor rat was created, it was exposed to a gas mixture such as PCO=400hPa, PCO_2 =100hPa, PO_2 =900hPa and PHe=5,600hPa in a 7ATA high-pressure chamber, and was preserved in a refrigerator at 4℃. We herein present our findings which demonstrate that significant reproducibility has been verified. The heart was removed from the refrigerator 72 hours later, and a heterotopic heart transplantation was performed in the right neck of the recipient rat, and the pulsating of the transplanted heart was detected by an electrocardiogram.

Scientific Session G: Hyperbaric Medicine 1 **G1**

HYPERBARIC OXYGEN THERAPY IN TOKYO MEDICAL AND DENTAL UNIVERSITY HOSPITAL

Kazuyoshi Yagishita, Yoshihiro Mano, Nobuo Yamami, Seiichiro Togawa, Yasushi Kojima
Hyperbaric Medical Center, Tokyo Medical and Dental University. Yushima 1-5-45, Bunkyo-ku, Tokyo 113-8519, JAPAN

Introduction: Multiplace chamber in our university hospital was set up in 2001. Our chamber includes 3 treatment rooms and 16 patients can be treated at the same time. In 2007, 7970 times hyperbaric oxygen therapy (HBO) in 958 patients were performed in our university hospital, which is the most patients number in one institute in a year in Japan. The purposes of this study were to evaluate and to report the diseases and the patients performed with HBO in our hospital in 2007.
Patients and Methods: 7970 times HBO in 958 patients were performed in our hospital in 2007. The number of the patients and HBO times were evaluated.
Results: The number of the patients and HBO times in decompression illness were respectively 374 patients and 764 times, 87 patients and 934 times in sudden deafness, 34 patients and 740 times in peripheral vascular disorder including diabetes and arteriosclerosis obliterans, 47 patients and 1046 times in osteomyelitis, 180 patients and 865 times in soft tissue injury related sports activity, 90 patients and 1644 times in myelopathy and radicuropathy, 19 patients and 220 times in carbon monoxide poisoning, and 18 patients and 259 times in radiation-induced cystitis.
Discussion: In HBO treatment in our university in 2007, no major patient troubles and no chamber problems were recorded.

Scientific Session G: Hyperbaric Medicine 1 **G2**

CARBON MONOXIDE AS A SIGNAL TRANSDUCER

Nariyoshi Shinomiya[1], Satoru Watanabe[2], Hirotaka Matsuo[1], Shinya Suzuki[2]
[1]Department of Integrative Physiology and Bio-Nano Medicine, National Defense Medical College, and [2]Division of Environmental Medicine, National Defense Medical College Research Institute, 3-2 Namiki, Tokorozawa, Saitama 359-8513, Japan

Carbon monoxide (CO) is a colorless, odorless gas that is produced by incomplete combustion of carbonaceous material. On the one hand, CO induces severe toxicity to living body and the patients with CO toxicity complain of cerebral or cardiovascular symptoms, which result from cellular hypoxia caused by the formation of carboxyhemoglobin (HbCO). On the other hand, CO is produced endogenously by heme oxygenases and acts as a signaling agent. There is uncanny resemblance between CO and nitric oxide. Both molecules share an affinity for the heme molecules, and both are known to activate guanylate cyclase that has biological activities as a second messenger. CO is not a byproduct but a functional molecule in vivo, for example CO has neurotransmitter-like actions such as the induction of gut peristalsis, ejaculation, and the stimulation of olfactory nerves. Also, CO has cytoprotective effects on damaged livers, improves circulation by inhibiting platelet aggregation or by regulating vascular tone, and acts as antiinflammatory signals.
Recently, some effects of CO are considered to be

mediated through the mitogenactivated protein kinase (MAPK) pathways. CO is reportedly to up-regulate LPSinduced activation of the p38 MAPK in macrophages and shows anti-inflammatory effects. Also, CO attenuates endothelial cell apoptosis during anoxia-reoxygenation injury by activating MKK3/p38 MAPK pathways. The anti-apoptotic effects of CO depend upon both phosphatidylinositol 3-kinase/Akt and p38 MAPK signaling pathways. Thus, a new role for CO as a signal transducer via MAPK pathways is getting attention.
Here, we show that the activation of MAPK signals and the induction of apoptosis occur in neural cells which received excess amount of CO. In the patients with CO toxicity, not all the signs and symptoms can be explained only by hypoxia due to the formation of HbCO. We discuss the possibility of the involvement of MAPK activation in the pathophysiology of CO toxicity.

Scientific Session G: Hyperbaric Medicine 1 G3

VASCULOGENC STEM CELL STIMULATION BY HYPERBARIC OXYGEN IN VIVO

Stephen R. Thom, Veena M. Bhopale and Tatyana N. Milovanova
University of Pennsylvania Institute for Environmental Medicine 3620 Hamilton Walk, Philadelphia, PA USA 19104-6068

We hypothesize that oxidative stress from exposure to hyperbaric oxygen (HBO_2, 2.8 ATA for 90 minutes daily) exerts a trophic effect on vasculogenic stem cells. In a mouse model, mobilization of circulating stem/progenitor cells (SPCs) from bone marrow, recruitment to-and differentiation within-subcutaneous Matrigel was stimulated by HBO_2 and also by a physiological oxidative stressor, lactate. In combination HBO_2 and lactate have additive effects. Vascular channels lined by $CD34^+$ SPCs were identified. HBO_2 and lactate accelerated channel development, cell differentiation based on surface marker expression and cell cycle entry. Cell recruitment to Matrigel and protein synthesis responses were abrogated by antioxidants (N-acetyl cysteine and dithioerythritol), neutralizing anti-VEGF or anti-SDF-1 antibodies, and small inhibitory RNA to thioredoxin reductase, hypoxia inducible factor (HIF)-1 or HIF-2. We conclude that HBO_2 and lactate individually and in combination cause SPCs oxidative stress that accelerates vasculogenesis by stimulating the thioredoxin system, HIF-1 and -2 elevations and subsequent synthesis of HIF-dependent growth factors.

Scientific Session G: Hyperbaric Medicine 1 G4

EFFECTS OF HYPERBARIC OXYGENATION ON VASCULAR PROTEIN OF SPONTANEOUSLY HYPERTENSIVE RATS

Teruhiro Nakada, Yuichi Shinoda, Masahiko Kodaira, Yasuyo Nakajima, Yasuyuki Yoshida, Yoko Kubota
1830-1, Yoshioka, Yotsukaido City, Chiba Prefecture, 284-0032, Japan

We proposed that increased non-collagenous protein synthesis in the small artery in young spontaneously hypertensive rat (SHR) was related to the sympathetic nerve activiy, and could be reduced by antihypertensive drugs concomitant with lowering of high blood pressure. While hyperbaric oxygen (HBO) treatment failed to ameriolize hypertension, but suppressed the this protein synthesis slightly. This study tried to clarify the possible beneficial synergistic effect of α blocker and HBO treatment in young hypertensive animals. Male Wistar Kyoto rats (WKY), SHR, and stroke prone spontaneously hypertensive rats (SHRSP) were treated with either α blocker or HBO from 6 weeks of age to 8 weeks of age. At the age of 8 weeks each rats received an injection of ^{3}H-proline and was killed 2 hr afterwards. Collagen, Non-collagenous protein of mesenteric arteries and aortas were extracted. The radioactivity of each vascullar protein was determined. α blocker+HBO treatment decresed incorporation of ^{3}H-proline into the non-collagenous protein and collagen of mesenteric arteries with a reduction of hypertension in SHR and SHRSP. Similar effects were observed in α blocker-treated animals in lesser extent. Thus, increased synthesis of non-collagenous protein and collagen in small arteries apperas to regulate the genetic hypertension in SHR and SHRSP and α blocker+HBO treatment may play an important role for improvement of hypertensive vasular lesions.

Scientific Session G: Hyperbaric Medicine 1 G5

CLINICAL DYNAMICS OF SERUM REACTIVE OXYGEN METABOLITES AND BIOLOGICAL ANTIOXIDANT POTENTIAL, POST HYPERBARIC OXYGEN EXPOSURE

Suzuki N, Yamami N, Kongoji J, Yagishita K, Togawa S, Shibayama M, Suzuki R, Matsumoto Y, Yamamoto K, Mano Y
ORTHO MEDICO Inc. Research&Development Department Open Lab, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8519, Japan

Introduction: Hyperbaric oxygen therapy (HBO) is clinically applied for treating not only decompression illness but also wound healing acceleration. The unit of pulmonary toxicity dose, respiratory examination, and diagnostic radiological imaging are the commonly used methodologies to detect the side-effects of HBO. However, for an early diagnosis, more convenient and reliable tests are required. The purposes of this study were to investigate whether the clinical application of HBO could have toxic effects by measuring with the several factors of the oxidative and anti-oxidative metabolites.

Materials and Methods: The subjects in this study were 10 healthy Japanese adults with 3 females and 7 males (mean age 32.8 ± 5.4yrs). They were exposed to hyperbaric oxygen and inhaled 100% oxygen flow (15L/min) following the US Navy Treatment Table 6. Blood samples were collected from the antecubital vein before and after HBO. Samples were immediately measured for the level of reactive oxygen metabolites (ROM), biological antioxidant potential (BAP), serum coenzyme Q_{10} (CoQ_{10}), oxidized CoQ_{10}, serum lipid peroxides (LPO), and serum superoxide dismutase (SOD). Urine hexanoyl-lysine (HEL) and 8-hydroxydeoxy-guanosine (8-OHdG) were evaluated as well.

Results: There was an increase of 6.9% in the serum ROM (315.3 ± 52.5 CARR.U to 337.0 ± 53.5 CARR.U, $p<0.01$). Additionally, a 43.1% increase in urine 8-OHdG ($p=0.07$) was detected as well. Other markers did not show significant change. Conclusion: From our study, we conclude that ROM might be a useful biomarker to predict physiological changes due to application of HBO.

Scientific Session H: Hyperbaric Medicine 2 H1

TRANSIENT LETHAL ARRHYTHMIA DURING HYPERBARIC OXYGEN THERAPY IN A PATIENT WHO UNDERWENT LIVER TRANSPLANTATION

Hiroshi Dohgomori, Kenichi Nitta, Masataka Ozawa, Satoko Joshita, Takayuki Watanabe, Minori Ikegami, Masahiro Maruyama, Hiroshi Takayama, Tadashi Kikuchi, Masatomo Kitamura, Mitsuhide Hirabayashi, Tomomi Iwashita, Hiroshi Imamura, Kazufumi Okamoto

Department of sEmergency Medicine and Critical Care, Shinshu University Hospital, Matsumoto, 3-1-1, Matsumoto, Japan

We encountered a lethal arrhythmia during hyperbaric oxygen (HBO) session to treat his hyperbilirubinemia: he underwent liver transplantation and then suffered liver dysfunction. At his eighth HBO session, we observed a lethal arrhythmia, ventricular tachycardia. The arrhythmia disappeared soon and the session was canceled at the point. He did not complain any other symptoms. Additional examinations, however, could not reveal its causes. Arrhythmia can appear in many situations. HBO is a different situation from those experienced under 1ATA. In many hospitals in Japan, HBO has been performed using one man chamber like ours. HBO should be performed with strict considerations for many possible situations.

Scientific Session H: Hyperbaric Medicine 2 H2

HYPERBARIC OXYGEN THERAPY FOR DIABETIC FEET

Shizuka Muraoka[1], Mahito Kawashima[1], Hiroaki Tamura[2], Makoto Sasaki[1], Ikufumi Nagayoshi[1], Masayuki Kawashima[1], Katsuhiro Takao[1], Takashi Yamaguchi[1], Kenji Miyata[1]

[1]Kawashima Orthopaedic Hospital, 14-1 Miyabu, Nakatsu-shi, Oita-ken, 871-0012, Japan

[2]Kawashima Clinic, 17 Miyabu, Nakatsu-shi, Oita-ken, 871-0012, Japan

Background: Pathological lesions in feet for patients with diabetes, blisters, ulcers, and sphacelus, are generically called Diabetic feet. They have various prognosis and sometimes we are forced to amputate. Hyperbaric Oxygen therapy (HBOT) is aggressively carried out for them at our hospital. The purpose of this study is to evaluate the outcome of HBOT for diabetic feet.

Method: Subjects of this study consisted of 72 patients with diabetic feet (81) underwent HBOT in our hospital between March 1987 and June 2008 (48 men, 24 women). Feet with arteriosclerosis obliterans (ASO) were 33.

Result: Therapy was concomitant HBOT with medication and surgical procedure. The result of our therapy is classified as follows: healed wounds as 'excellent', a 50% reduction of wounds as 'good', and non healed wounds or amputation as 'failure'. Excellent - 42, good - 25, and failure -14. Among ASO cases Excellent -14, good -9, and failure -10.

Conclusion: Diabetic feet caused by an arterial obstruction and peripheral neuropathy. The most important therapy for diabetic feet is glycemic control, but HBOT is available for early-stage wounds, and makes it possible to decrease the number of amputations as well as to limit dimension of amputation.

Scientific Session H: Hyperbaric Medicine 2 H3

HYPERBARIC OXYGEN THERAPY FOR INFECTIOUS PSEUDOARTHROSIS

Hiroaki Tamura[1], Mahito Kawashima[2], Makoto Sasaki[2], Ikufumi Nagayoshi[2], Masayuki Kawashima[2],Katsuhiro Takao[2], Takashi Yamaguchi[2], Kenji Miyata[2]

[1]Kawashima Clinic, 17 Miyabu, Nakatsu-shi, Oita-ken, 871-0012, Japan

[2]Kawashima Orthopaedic Hospital, 14-1 Miyabu, Nakatsu-shi, Oita-ken, 871-0012, Japan

The infectious pseudoarthrosis is a difficult reconstructive problem for the surgeon and too often becomes a chronic illness for the patient. More often than not the patient has endured multiple hospitalization, many operative procedures, and prolonged treatments with parenteral antibiotics. Ischemia is an important consideration in nonhealing, infected fracture and usually is associated with those injuries severe enough to disturb the blood supply to the fracture site. Hyperbaric oxygen therapy (HBO) is useful in these conditions for the same reasons that it is useful in refractory osteomyelitis.

Since 1982, we treated 33 cases of infectious pseudoarthrosis. Average number of previous surgical procedure before admission was 4.4 times (1 ～ 20 times) and average duration of infection was 11.6 months (1 ～ 40 months). We had been treated the infectious pseudoarthrosis with a combination of antibiotics, surgery, and HBO. Of the 33 cases, 28 healed and discharge diminished 3 cases. One case was done the below knee amputation and one moved another hospital. HBO is effective for infectious pseudoarthrosis in order to improve host factor such as neovascularization, white blood cell oxidative killing, and osteoclastic activity.

Combination of HBO and closed suction irrigation therapy is more effective.

Scientific Session H: Hyperbaric Medicine 2 H4

HYPERBARIC OXYGEN CONCURRENT WITH INTRAARTERIAL CARBOPLATIN CHEMORADIOTHERAPY ENHANCES SURVIVAL OF PATIENTS WITH ORAL CANCER

Ryoichi Oya[1], Soichi Hirashima[1], Toshiyuki Akimori[1], Chisa Kubo[1], Kotaro Shimoji[1], Ryuichiro Inenaga[1], Shoichi Nakamura[1], Nobuhide Konda[2], Takayuki Okuri[3], Katsuya Yahara[3], Junji Moriya[3], Shingo Kakeda[3], Nobuhiro Onari[3], Yukunori Korogi[3]

[1]Department of Oral and Maxillofacial Surgery, [2]Division of Hyperbaric Medicine,

[3]Department of Radiology, University of Occupational and Environmental Health

Hypoxic cell fraction within a tumor tissue decreases effect of radiotherapy and chemotherapy, and provides poor prognosis. As oxygen tension of tumor tissue is kept higher than that of normal tissue after hyperbaric oxygen (HBO), recent study suggests that irradiation after HBO exposure within fifteen minutes enhances antitumor effect of radiotherapy in malignant tumors. We evaluated retrospectively effect of HBO concurrent with intra-arterial carboplatin chemoradiotherapy in patients with oral cancer. A hundred-one patients with oral cancer including recurrent lesion or cervical lymph node metastasis were treated with superselective intra-arterial carboplatin infusion, external beam radiotherapy, UFT (tegafururacil) and/or surgery from April 1995 to June 2008 at our institution. Among these patients 51 were combined with HBO, 50 without HBO exposure. Exposure to HBO was administered in a multiplace hyperbaric chamber according to the following schedule: 13 min of compression with air, 60 min of oxygen inhalation using oxygen mask with a reservoir at 2.5 atmospheres absolute, and10 min of decompression with oxygen inhalation. Radiotherapy was performed immediately after HBO exposure five times weekly.

Among 51 tumors treated with only chemoradiotherapy without surgery, 30 were combined with HBO (CR-wHBO group), 21 without HBO (CR-woHBO group). Amomg 50 tumors resected after preoperative chemoradiotherapy, 20 were combined with HBO (S-wHBO group), 30 without HBO (S-woHBO group). A disease-specific survival rate of patients with HBO (70%) was significantly higher than that of patients without HBO (40%) (p=0.012). Also, a disease-specific survival rate of patients for five years in each group revealed as follows, S-wHBO group; 86%, S-woHBO group; 60%, CR-wHBO group; 53%, CR-woHBO group; 27%. There was a significant difference between survival rate of each group by Logrank test (p=0.003). These results suggest that adding HBO to intra-arterial carboplatin chemoradiotherapy enhanced survival of patients with oral cancer.

Scientific Session H: Hyperbaric Medicine 2 H5

HYPERBARIC OXYGEN THERAPY (HBO) FOR BLINDING VASCULAR OCCLUSIONS OF THE RETINA (VOR) －EXPERIENCE OF 201CASES (206 EYES) PAST 20 YEARS －

Inoue O[1], Kajiya S[2], Yachimori R[2], Sawaguchi S[2]

[1]Hyperbaric Medicine

[2]Ophthalmology, Ryukyu University Hospital, 270 Uehara Nishihara-cho Okinawa, 903-1225, Japan

[BACK GROUND] Currently VOR are increased with hypertension or diabetes. Central retinal artery occlusion (CRAO) occurs by rapid reduction of visual acuity (VA) similar to cerebral stroke. Branch retinal artery occlusion (BRAO) often accompanies with visual field defect (VFD). Central retinal vein occlusion (CRVO) is a cause of permanent blindness secondary to diabetic retinopathy. Retinal branch vein occlusion (BRVO) may ensue with visual disturbance. Neither medications, photocoagulation, ophthalmic interventions evidenced the effectiveness. This report will be the largest series to reveal the favorable effect of HBO on VOR.
[CASES] CRAO was 62 cases 63 eyes (average 62 year-old) whose symptoms at admission were no light perception (NLP) in 4 cases, light perception (LP) in 5, hand motion (HM) in 23, finger counting (FC) in 5, highly decreased visual acuity 0.010.1 (HD) in 16, slightly decreased visual acuity over 0.2 (SD) in 9 which were included 17 visual field defect (VFD). BRAO was 46 cases 46 eyes (59 y-o), 1 NLP, 1 LP, 10 HD, 28 SD included 21 VFD. CRVO was 67 cases 70 eyes (60 y-o), 2 HM, 22 HD, 46 SD. Macular edema (ME) was complicated in 91.0%. BRVO was 26 cases 27 eyes (58 y-o), 3 HD, 24 SD with ME 77.7%.
[TREATMENT] For CRAO, HBO was begun on onset day in 13 eyes, by 3rd day in 29. For BRAO on onset day in 5, by 3rd day in 16. 2.8 ATA=60 min. 1 ～ 2 /day was conducted for CRAO average 22.3 times or BRAO 11.2. For CRVO (14 non HBO), HBO was begun within a month in 35, for BRVO within a month in 12. 2.0 ～ 2.8 ATA=60 min. 1/day was conducted for CRVO av. 16.9 or BRVO av. 20.2.
[RESULTS] 38% of CRAO improved VA over two lines (otl). Even over 3 days after onset, 45% improved otl. The more VA was maintained at the onset, the improvement was better, while even 30% of impending blindness (NLP, LP) improved otl. 75% of BRAO improved VA otl. Even over 3 days after onset 63% improved VA otl. Only 45% of BRAO improved VFD. 44% of CRVO improved VA otl by the end of HBO. However two months after HBO, only 26% improved VA which was almost equal to non HBO group. Improvement in 2.8 ATA group was better than either in 2.4 ATA or 2.0 ATA. VA was improved only when macular edema was diminished. 55% of BRVO improved VA otl in which 1/3 improved over four lines. VA was maintained or even improved far after HBO.
[CONCLUSION] Neither Urokinase or stellate ganglion block altered the combined effects with HBO, so HBO revealed the independent therapeutic effect. Although CRVO revealed only a temporary effect to improve VA, it would be necessary to repeat HBO by higher ATA until VA or macular edema was stabilized.

Scientific Session H: Hyperbaric Medicine 2 H6

MANAGEMENT OF FOURNIERS DISEASE − NECROTIZING SOFT TISSUE INFECTIONS OF THE GENITALIA

Roy A. Myers M.D., Paul Lucas M.D., Amid Jhaveri M.D., Robert J. Falconer M.D.
R.A.Cowley Shock Trauma Center. University of Maryland Medical Center.
Baltimore Maryland United States of America.

A retrospective chart review of One hundred and thirty one patients with necrotizing soft tissue infection of the gentialia seen at a single institution over a thirteen year period was conducted. Two time frames – March 1985 through June 1993 (8 years) and July 1993 through June 1998 (5 years) were compared for outcomes, hospital course and length of stay. One surgeon was involved in 90% of the all cases.
In the first cohort, traditional conservative surgical management with multiple incision and drainage procedures and excision of necrotic tissue were implemented.
In the second cohort, very agressive initial surgery and early second and third look operations with early wound closure with local advancement of tissue flaps and wound closure including obliteration of dead space was implemented.
In both cohorts broad spectrum antibiotics were started on admission and rapidly tailored to specific antibiotics based in culture and sensitivities. Initial Hyperbaric Oxygen was at 45 psi with 90% oxygen 8 hourly for 48 hours. Then twice daily at 33 psi till wound closure.
The results of the aggressive management in the second cohort was a reduction in mortality from 36% to 16 % and a reduction in length of stay from 57.4 days to 24.8 days. There was also less surgical procedures – debridements, reconstruction and split thickness skin grafts.
The conclusion is that early aggressive repeated surgery, broad spectrum antibiotics and Hyperbaric Oxygen therapy greatly improves the outcome of necrotizing soft tissue infections of the genitalia.

Scientific Session H: Hyperbaric Medicine 2 H7

HYPERBARIC OXYGEN THERAPY FOR CRUSH INJURY

Mikio Shioda[1], Katsuhiro Takao[1], Mahito Kawashima[1], Hiroaki Tamura[2], Makoto Sasaki[1], Masayuki Kawashima[1], Ikufumi Nagayoshi[1], Takashi Yamaguchi[1], Kenji Miyata[1]
[1]Kawashima Orthopaedic Hospital, 14-1 Miyabu,

Nakatsu-shi, Oita-ken, 871-0012, Japan
[2]Kawashima Clinic, 17 Miyabu, Nakatsu-shi, Oita-ken, 871-0012, Japan

It is imperative how to treat large musculoskeletal crush injuries correctly since unsuitable treatment might lead to wound tissue ischemia which results in amputation, severe infection and wound healing compromised. Hyperbaric oxygen therapy(HBO) is an effective treatment for crush injury since HBO can prevent wounds from severe infection and also enhance the healing process. We have already reported that HBO has a good result in crush injuries. In this time we reported with additional cases which indicated the effectiveness of HBO.
METHODS: We used the hyperbaric oxygen chamber made by NAKAMURA IronWorks. Oxygen inhalation was administered for 60 minutes daily under conditions of 2.0 or 2.8ATA. In this paper, we reviewed 169 crush injuries cases that were treated with HBO between June 1981-December 2007 in our hospital.138 male and 31 female patients were included, aged between 4-81years old (average46.3)
Cases by age are as follows: 35 cases for 50s, 33 cases for 60s, 30 cases for 40s and 25 cases for 20s.
lesions involved hands in 72 cases, feet in 39 cases, lower extremities in 33 cases, antebrachium in 6 cases, inferior limbs in 6 cases, superior limbs in 4 cases, knees in 3 cases, arm in 2 cases elbow in 1 case ankle in 1 case and a femur in 1 case.
RESULT: There was a complete recover in167 cases among 169 cases. Toe amputation was needed in 2 cases.
CONCLUSION: HBO for crush injuries have great merits such as improvement of tissue ischemia, reduction of edema, prevention of infection and enhancement of the wound healing process. These merits are considered to work together and prevent patients from amputation and sequela.

Scientific Session H: Hyperbaric Medicine 2 H8

HYPERBARIC OXYGEN THERAPY FOR REFRACTORY ULCER

Takashi Yamaguchi[1], Ikufumi Nagayoshi[1], Mahito Kawashima[1], Hiroaki Tamura[2], Makoto Sasaki[1], Masayuki Kawashima[1], Katsuhiro Takao[1], Kenji Miyata[1]
[1]Kawashima Orthopaedic Hospital, Miyabu14-1, Nakatsu-shi, Oita-ken, 871-0012, Japan
[2]Kawashima Clinic, Miyabu 17, Nakatsu-shi, Oita-ken, 871-0012, Japan

Background: The refractory ulcer is caused by various reasons and we are difficult often to cure them completely. In Kawashima Orthopaedic Hospital, we are treating them by hyperbaric oxygen therapy (HBOT) as an adjunctive therapy for improvement of hypoxia, inhalation of renovation in injured organs, and prevention of infection. We considered the effect of HBOT.
Method and Subject: From 1981 to 2007, 240 (154 male, 86 female) cases, 254 sites of refractory ulcer ware administrated in our facilities. The patients age ranged from 9 to 92 years old (average 62.4). All of them were treated with medication, surgical treatment, and HBO. Infusion of Prostagrandin or/and antibiotics were used as medication. Dressing and disinfection were carried out as surgical treatment. HBOT is carried out once a day under conditions of 2.0 ATA 60 minutes.
Causes of the ulcer was, 63 cases ware arteriosclerosis obliterans (ASO), 13 case were Buerger disease, 27 cases were the other blood flow trouble, 76 cases were diabetes mellitus, 11 cases were thermal burn, 37 cases were trauma, 6 cases were post amputation or skin graft operation, and 3 cases were radiation ulcer. The criterion of the treatment was set as follows: healed wounds as 'excellent', a 50 % reduction of wounds as 'good', and non headed or amputation as 'failure'.
Result: Except 10 cases of drop out of HBO, the results of treatment were as follows: excellent-164 parts, good-48 parts, and failure- 42 parts.

Luncheon Seminar 2 S2

BUBBLE OF DCS AND NANO · BUBBLE

Yoshihiro Mano, M.D., Ph.D.
Emeritus Professor, Tokyo Medical & Dental University

The size of a nano bubble is less than 200 nano meter (0.2 μ). One micron(μ) is 1,000 nano, so nano size is too little not to find.
Decompresion sickness (DCS) occurs by bubble formation during/after decompression and usually the diameter of the formed bubble are over than near 50 micron which we can find out by dopler detect observation. There needs preesisting gas nuclei in tissue (the human body) whenever bubbles must be formed after diving. So, DCS must perfectly be prevented after diving if we could crush every gas nuclus in our body before ascent.
We had been observated the distribution of original gas nuclei of DCS in the 1970s and found that it would be existed between 0.1 and 1.35 μ in diameter and the gas nuclei became to bubbles when the nuclei grew over than 1.35 μ from our experiment.
Are there no more gas nuclei less than 0.1 μ ?

The answer is NO. The distribution curve of pre-existed gas nuclei is a very simple exponential form. There must exist in such smaller gas nuclei theoretically in actuality. We have been considering the distribution curve less than 0.2 μ during a few decades and have eventually noticed the existence. We call nano bubble water in which the smaller gas nuclei less than 0.2 μ (200 nano size) are clearly dessolved. These nano bubbles are melting in the solution liquid (tissues) and never form bubbles. When it disappears in the water, hydroxyl radical (・OH) generates in water. We can catch ・OH by the ESR (Spin Trapping Resonance) method. We can also notice that this nano bubble water has strangely special power for life science. It was proved at the Aichi World Fair in 2004 that sea and fresh water fish had lived together in the same pool and had a good appetite, then had been quite healthy during the term more that 9 months. More over, all of skin diseases like as carp herpes had been cured. Nano bubbles water has produced effective phenomena not only in fish and a plant but in human being. Nano bubbles water owns the effect of dis-infect, preserving, regenerating and restoring tissues by the powers. For examples, oral aphtha will be cured through rinsing by 20 ml of nano bubbles water for 20 seconds per a few times per day from one to three days.

We can avoid taking a cold, have a good appetite and sleeping, avoid having a hangover, become eager to live, and eventually get our health back.

Nano bubbles water becomes to the useful means for our future life.

I would like to present some examples except the cases concerned with a patent applying for now.

Lecture For Citizen 1 (in English) **L1**

INTRODUCTION OF SCIENCES AND DUCTH LEARNING IN THE EDO PERIOD OF JAPAN

Harmen Beukers
Leiden University

From the 1630s till 1854 Japan was more or less a closed country and restricted it commercial relations to China and Holland both through Nagasaki. Western sciences were mainly introduced by the Dutch settled on the artificial island Deshima in the harbour of Nagasaki. Because of the strict regulations concerning contacts with foreigners the possibilities for exchanges of knowledge were limited to visits of Japanese to Deshima or to contacts during the court journey to Edo. In both cases the interpreters played a crucial role. Some of them became specialists in 'Dutch medicine' and were responsible for the regional spread of western medical knowledge in Kyushu.

Except for private interests of higher officials in botany and medicine in the seventeenth century, the real impetus for the study of western sciences came from shogun Tokugawa Yoshimune in the early eighteenth century. He encouraged scholars to interview the Dutch during their stay in Edo about astronomy, medicine, botany and geography. He ordered his librarian Aoki Kon'yō and the court physician Noro Genjō to study Dutch. The latter was involved in a partial translation of the herbal by Dodonaeus. After Yoshimune' s death, in 1751 the interest in western sciences was no longer the shogun' s concern. Daimyo took over the initiative, like the lord of Nakatsu.

Followers of a special school of Chinese medicine began with anatomical dissections (Yamawagi Tōyō, 1754) and learned to appreciate the figures in Ducth anatomy books. A group of physicians in Edo, among whom Sugita Genpaku and Maeno Ryo taku were prominent, took the initiative to translate the Dutch edition of Kulmus' anatomy book. Maeno, physician from Nakatsu and well versed in Dutch, was crucial in the translation process. However, the book was published by Sugita under the title Kaitai shinsho '(A new book on anatomy' , 1774). The book initiated a new branch of learning, Rangaku (Dutch Learning). Specialists in this field began to translate Dutch books covering many different aspects of western knowledge. A good example is the Udagawa family which in three generations successively translated books on internal medicine, materia medica and chemistry.