DECOMPRESSION SICKNESS (DCS) -“THE BENDS”

Background
1. Definition: DCS is result of improper decompression after exposure to higher levels of compression (usually diving).
   - Signs and symptoms are normally the result of air bubbles forming in joints and other tissues
     - Cause mechanical and biochemical effects.
2. Decompression Illness (DCI) is a more broad diagnosis that includes DCS and Arterial Gas Embolism (AGE).1,2
3. Described for over 200 years
   - Initially in tunnel diggers-Caisson Disease1,2
4. Common due to increase in recreational, no-decompression, SCUBA diving
5. Case reports of incidents at altitude not related to diving
   - Normally military aircraft3

Pathophysiology
1. Release of inert gases dissolved into blood stream under high pressure, mostly nitrogen, from physical solution with resultant bubble formation after decompression.
   - Bubbles can have mechanical, embolic and biochemical effects1,2
2. DCI includes DCS and AGE.
   - DCS mechanics like Arterial Gas Embolism (AGE) but different symptoms
3. Incidence of non-fatal DCS 0.01% (9.57/100,000 dives)4
4. Risk Factors1,2
   - Gas burden (“depth and time”); not following dive tables
   - Multiple dives
   - Immersion in water
   - Environment: cold water and higher altitude for SCUBA
   - Obesity
   - Older (over 50)
   - Flying within 12 hours of diving
   - Exercise-at depth and after the dive5
5. Morbidity / Mortality2
   - 80% will have complete recovery
   - Even with severe DCS only 27% will have long term complications

Diagnostics
1. History
   - See Diving history for more details
   - Detailed history of all dives/times, ascent rates, intervals between dives, breathing gases and complications with dive
   - Symptom times and progression after diver has surfaced from last dive
   - Get detailed first aid information including all measures and their effect on symptoms
   - Record results of neuro exam done on site
   - Describe all joint or other musculoskeletal pain including: location, intensity and changes with movement/weight-bearing
   - Describe distribution of any rashes
   - Describe any traumatic injuries before, during and after dive
2. Physical Examination
   o No longer divided into types I & II DCS
   o Wide range of symptoms
     ▪ Any new symptoms after decompression should be considered as possible DCS
   o Neurological Exam is crucial for all DCS injuries
   o Pain: most common initial symptom and most common overall
     ▪ 68% of cases
     ▪ 58% joint pains (most common distribution in recreational SCUBA), 35% muscle pains, & 7% girdle pains
     ▪ Joint crepitus/subcutaneous crepitus
   o Numbness/paresthesias
     ▪ 63.4% of all cases
     ▪ Can easily be missed if proper neurological exam not performed
   o Constitutional symptoms 48% of cases: headache, fatigue, malaise, nausea/vomiting or anorexia
   o Cutaneous symptoms
     ▪ 9.5% of cases
     ▪ Pruritus or marbling
   o CNS symptoms
     ▪ Cerebral DCS
       ▪ Seizures, hemiplegia, diplopia, tunnel vision or scotomas
       ▪ Progress to AMS (altered mental status), coma or death
       ▪ 18.7% of all cases have weakness
       ▪ Less than 8% have other findings
       ▪ 27% of CNS DCS will still be present at one month
     ▪ Labyrinthe involvement (“the staggers”)
       ▪ Vertigo, nausea, vomiting, deafness, tinnitus and nystagmus
       ▪ Immediate treatment important due to small vasculature
       ▪ Must exclude inner ear barotrauma (Electronystagnography)
   o Pulmonary symptoms (“the chokes”)
     ▪ Massive blocking of pulmonary circulation by bubbles
     ▪ Substernal pain, cough and dyspnea
     ▪ Usually occurs within minutes
     ▪ 5.6% of cases
     ▪ Can lead to respiratory failure and shock if not treated immediately
   o Other less common symptoms include bladder, bowel, GI and cardiovascular symptoms.

3. Diagnostic Testing
   o Neuropsychiatric testing for evaluation of subtle CNS findings

4. Laboratory evaluation by recommendation of Undersea and Hyperbaric Medicine Society (UHMS)
   o CBC: evaluate for DIC
   o BMP: evaluate for hypoglycemia
   o Toxicology screen: evaluate for other causes
   o CPK: some evidence shows AGE elevated vs. normal in DCS

5. Diagnostic imaging
   o Plain film imaging: evaluate for gas
   o Electronystagnography: decide inner ear DCS vs. barotrauma
6. Diagnostic criteria
   o SANDHOG and RNZN, two clinical scales previously studied to help diagnose DCS
     ▪ Limited clinical usefulness\(^7,8\)

**Differential Diagnosis**
1. Key Differential Diagnoses
   o Inner ear barotrauma
   o Middle ear/maxillary sinus over-inflation
   o Contaminated diving gas
   o Oxygen toxicity—especially with use of Nitrox
   o MSK strains
   o Seafood toxin ingestion
   o Immersion pulmonary edema
   o Water aspiration

**Therapeutics**
1. Acute Treatment
   o Surface Oxygen 100% NRB facemask (SOR: C)\(^9\)
     ▪ Do not use ENTOX (50% O\(_2\) 50% N\(_2\)) as this can exacerbate pneumothorax
   o In-water recompression should only be done in remote areas\(^10\)
   o US Navy (USN) and UHMS guidelines support recompression then controlled decompression following USN Dive Table 6\(^2,6\)
     ▪ Hyperbaric Oxygen
     ▪ Reduces bubble size and improves absorption
     ▪ Reverses tissue hypoxia
   o Contact Diver’s Alert Network (DAN) at 919-684-9111
   o NSAID’s show conflicting evidence (SOR: C for ASA and SOR: B for ibuprofen)\(^9\)
   o IV fluids bolus NS or LR (SOR: C)\(^9\)
2. Further Management (24 hrs)
   o May require repeat chamber trips
   o Use LWMH for those with leg immobility (SOR: A)\(^9\)
   o Conflicting data for IV lidocaine as adjunct to HBOT (SOR: B)\(^9\)
   o Do not use steroids (SOR: B)\(^9\)
   o Transport via ground if possible
     ▪ Aircraft maintain maximum cabin altitude of 1000 ft above sea level\(^11\)
3. Long-Term Care
   o All patients should be transferred to facilities with hyperbaric oxygen chamber

**Follow-Up**
1. With mild and moderate DCS divers normally can return to sport in 4 weeks
2. Severe DCS, with cerebral DCS or continued symptoms, should not return to diving until cleared by a Diving Medical Specialist

**Special Situations**
1. DCS in free divers
   o Rare
- Multiple dives with short surface intervals
- See above for treatment

### Prevention
1. All divers should have pre-dive medical clearance
2. Safety stops (3-5 minutes at 10-20 feet)
3. Ascend slowly ($\leq 30$ ft/min)
4. Use a dive computer/dive table
5. Plan dive carefully
6. Keep fit, well hydrated and avoid alcohol
7. No flying until 12 hours after a single dive
8. No flying until 18 hours after a series of multiple dives

### Patient Information
1. Diver’s Alert Network-Medical Frequently Asked Questions

### References

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