

You're the Flight Surgeon

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You're a flight surgeon at a military aviation medicine clinic. You are asked to see a "complicated" patient at the request of the patient's assigned aeromedical provider who is overbooked. You readily agree to see the patient, happy for something different than the steady stream of healthy 20-something-year-olds reporting for their yearly physicals. You walk into the examination room to what appears to be yet another aviation student in the prime of life and you wonder what is going to be "complex" about this case.

Your patient is a 24-yr-old Caucasian man who just came on active duty as an aviation student. His main concern today is that his hands "turn white" and become painful when he attempts to fly. He has just started his training in rotary wing aircraft and states that he loses dexterity and tactile sensation after grasping the cyclic and collective controls and finds it difficult to control the aircraft. The patient has never been a smoker and has no personal or family history of cardiovascular disease. He has not had any trauma, acute or repetitive, to his hands. However, he does have a history from an early age of heavy labor and power tool use growing up on a farm. When he informed his instructor pilot of his difficulties with the aircraft's controls, he was directed to the aviation clinic for evaluation.

Examination of his skin indicates nothing abnormal with his hands, face, or other areas. He has good grip strength, with no neurological deficits. However, he produces pictures on his smart phone from his last attempt at flight that show striking bilateral blanching of the palmar aspect of the length of his fingers. The student thought that the cause was the current cold weather, as his father has the same painful symptoms when the temperature drops. Thinking that the patient may have Raynaud Phenomenon, you decide to do a Cold Stimulation Test by submerging the patient's hands in ice water.

1. What is considered to be a positive result for the Cold Stimulation Test?

- A. Finger temperature that returns to prebath temperatures within 15 min.
- B. Finger temperature that does not return to prebath temperatures after 20 min or more.
- C. Discomfort while hands are submerged in ice water.
- D. Flushing and erythema of skin during cold immersion.

ANSWER/DISCUSSION

1. B. Raynaud Phenomenon is a common health problem with a prevalence estimated at 3.3–22%.⁶ It is characterized by episodic cyanosis, swelling, and pallor on both upper and lower extremities, often provoked by cold exposure. A typical Cold Stimulation Test protocol involves: 1.) measuring the temperature of the affected body part; 2.) submerging the affected body part in ice water for 20 s; 3.) measuring the temperature of the dried-off body part at 5, 10, 15 and 20 min; and 4.) recording the time until the affected body part is back to normal temperature. The cutoff has been set at 20 min or more to return to a normal temperature as an indication of possible Raynaud Phenomenon. Generally, your hands will return to a normal, prebath temperature within 15 min or less. Discomfort is felt by most people when a body part is submerged in ice water, regardless of pathology, and is not a sensitive or specific test for Raynaud phenomenon. Flushing and erythema are not a likely result while being submerged in cold water but can certainly occur after vasoconstriction has ceased.⁵

The student's hands are not affected to any significant degree by the ice water and the Cold Stimulation Test is negative. Wanting to see if a longer submersion in ice water would provoke actual symptoms, the student decides to submerge his hands again for a minute. It produces minimal discomfort, no blanching, cramping pain, or loss of dexterity. Because of these findings, you are on the fence about referring him to rheumatology. However, you decide to go forward with the referral knowing the father's history of similar symptoms in conjunction with a new disclosure that his father has been diagnosed with rheumatoid arthritis.

2. Which one of the following is usually sufficient to make a diagnosis of Raynaud Phenomenon?

- A. History and physical examination.
- B. Nailfold capillaroscopy.
- C. Vascular biopsy.
- D. Complete Blood Count (CBC), Blood Urea Nitrogen (BUN), and Thyroid-Stimulating Hormone (TSH).

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ANSWER/DISCUSSION

2. A. A thorough history and physical examination is generally considered to be the approach of choice for diagnosing Raynaud Phenomenon, but not necessarily whether it is primary or secondary. However, adjunctive tests like nailfold capillaroscopy, a visual method of analyzing microvascular abnormalities in autoimmune rheumatic diseases, may be used to help distinguish between Raynaud Phenomenon that is primary (no known underlying condition) and secondary (due to a condition such as lupus or scleroderma). Additional tests may be ordered to evaluate for polycythemic disorders, underlying malignancies or autoimmune disorders (CBC), renal impairment or dehydration (BUN) or thyroid disorders (TSH).⁴ The need for a vascular biopsy is very rare, though there have been cases of Giant Cell arteritis masquerading as Raynaud Phenomenon that were diagnosed by biopsy.⁸

As you explain the referral system at the clinic to the patient, he states that he has more concerns to discuss. The patient also complains about resting lower back and buttocks pain (3 out of 10) that is supportive of sciatica. He finds that the pain is exacerbated when he remains in any position, sitting, laying down, or standing, for an extended period of time. In addition, he has been experiencing increasing pain with exercise in his lower legs with the right worse than the left. You are now starting to see why your colleague described this patient as “complicated.”

With respect to his legs, further investigation reveals varying symptoms from numbness and tingling to severe pain. He has no recollection of ever injuring his legs. This week, he forced himself to run 2 miles with excruciating pain as the result. He complains that it often takes several hours for the pain and paresthesias to subside after he has completed a run. When you start discussing his options, he off-handedly adds that he has been worked up for compartment syndrome a few months ago and his anterior compartment of his right lower leg showed elevated pressures.

3. Which one of the following is not correct concerning compartment syndrome?

- A. An intercompartmental pressure (ICP) > 8 mmHg is the threshold pressure for diagnosis.
- B. The anterior compartment of the leg is the most common location for compartment syndrome.
- C. In acute compartment syndrome, fracture is the most likely cause.
- D. Clinical findings have poor sensitivities compared to ICP monitoring.

ANSWER/DISCUSSION

3. A. Though there are varying opinions as to what ICP is the cutoff for diagnosing compartment syndrome, traditionally, an intramuscular compartment pressure of greater than 30 mmHg has been used as a diagnostic threshold for diagnosing compartment syndrome. However, the addition of a perfusion pressure of less than 30 mmHg, has been shown to successfully augment the ICP cutoff for diagnosis. The anterior compartment is the most common location for compartment syndrome in the lower leg and traumatic tibial fracture the most frequent cause. The classic clinical signs and symptoms of an acute compartment syndrome include the 6 ‘P’s: pain, paresthesia, poikilothermia, pallor, paralysis, and pulselessness. Waiting for the full display of these

possible indicators is problematic as they appear late in the process and can delay treatment and worsen outcomes.²

The electronic medical record shows the results from a few months ago for an orthopedic treadmill test. It reveals a postexercise, right lower leg anterior compartment pressure of 78 mmHg. The note comes with a recommendation for a fasciotomy that the patient did not want at the time, but he is currently rethinking this choice. Oddly, it appears that the anterior compartment of his right leg was the only compartment tested; with the bilateral nature of his symptoms, you decide that a more thorough orthopedic evaluation is in order. You place him on a no running profile and recommend that he avoids other provocative exercise and temporarily remove him from flying duties. You conclude the visit, answering all the patient’s questions to his satisfaction and set a follow-up date post consult.

While waiting for the results of the consults, you mull over other less likely possibilities for the problems in this young aviator’s hands. Peripheral artery disease, a central source embolism, and Buerger disease seem unlikely considering his age and lack of tobacco use. However, autoimmune diseases, hand-arm vibration syndrome (HAVS), as well as hypothenar hammer syndrome (HHS), and thenar hammer syndrome (THS) are still on your differential.

4. What is the biggest risk factor for developing HHS and THS?

- A. A history of smoking tobacco.
- B. Family history.
- C. Coronary artery disease.
- D. Repetitive blunt or vibrational trauma to the palm of the hand.

ANSWER/DISCUSSION

4. D. Hypothenar hammer syndrome (aka “lemon squeezer’s hand”) and thenar hammer syndrome are attributed to repetitive trauma to the hypothenar and thenar eminences, respectively. HHS can be the result of trauma to the ulnar artery as it courses around the hook of the hamate bone in the wrist or interference with blood flow to this vessel as with a thrombus.³ THS is a result of similar pathology in the radial artery.¹ These syndromes often occur when workers repeatedly use the palm of the hand as a hammer to pound, grind, push, and twist hard objects. There currently is no significant correlation with HHS and THS and family history, coronary artery disease and tobacco use. Though, smoking cessation is strongly recommended for those with HHS and THS due to its deleterious effects on peripheral vasculature.³

After 2 weeks, the patient returns with the results of the rheumatology referral. Fortunately, there are no findings supportive of an autoimmune condition. The rheumatologist, however, has diagnosed the patient by EMG with bilateral carpal tunnel syndrome with Secondary Raynaud Phenomenon in the setting of Hand-Arm Vibration Syndrome (HAVS).

5. What is your aeromedical decision at this juncture?

- A. Refer to a hand surgeon to address the underlying cause of his secondary Raynaud Phenomenon.
- B. Wait until the results of his orthopedic examination before making any aeromedical decision.

- C. Send to physical therapy to address his carpal tunnel syndrome and refer back to his assigned aeromedical provider.
- D. Refer the patient back to his assigned aeromedical provider with a recommendation for permanent disqualification from flight.

ANSWER/DISCUSSION

5. D. After discussing with the appropriate aeromedical authority it was decided that the patient should be permanently disqualified from flight with subsequent removal from flight training. The decision was not made lightly and was based on the patient's status as a new student pilot with concerns for his ability to complete training, the aviation environment's impact on his health, and questionable longevity in an aviation career. It would be difficult to justify retaining a beginning flight student with the relative uncertainty of his prognosis with surgery and/or physical therapy for carpal tunnel syndrome. Also of concern is his demonstrated symptom provocation when at the aircraft's controls, as well as the lower back pain and compartment syndrome distractors. With all deference to HHS/lemon squeezer's hand, the juice was not worth the squeeze. Knowing the strict time schedule for initial flight training in the military, the dedication of extra medical resources in the hope that the service member would be able to return to full flight duties months or years down the road was not a viable option.

AEROMEDICAL DISPOSITION

U.S. military aeromedical guidance and Federal Aviation Administration regulations do not specifically address HAVS, but do cover Raynaud Phenomenon. U.S. Army Aeromedical Policy Letters (APLs) state that Raynaud Phenomenon is a disqualifying condition. Receiving a waiver is generally possible provided symptoms within the cockpit are manageable and underlying pathology has been excluded (i.e., Primary Raynaud Phenomenon). Symptoms triggered by cold weather, due to limitations in deployability, are viewed unfavorably in the waiver recommendation decision process by the U.S. Army. The Navy Waiver Guide states that Raynaud Phenomenon is considered disqualifying, with the primary phenomenon considered for waiver when underlying pathology is excluded and symptoms are manageable in the performance of flight duties. Waivers for secondary Raynaud Phenomenon are considered on a case-by-case basis.⁷ The U.S. Air Force Waiver guide states that the Raynaud Phenomenon is disqualifying for Flying Classes I/IA, II, IIU, and III. Waiver is likely for Primary Raynaud Phenomenon with or without the need for approved medication for classes II/III, but is less likely for I/IA when not needing medication and not possible when medication is required. Waiver is not

needed for ATC/GBC/OSF MOD when the primary phenomenon does not require medication and is likely if approved medication is used. Approvals for waivers involving Secondary Raynaud Phenomenon are approved on a case-by-case basis.⁹ Finally, the FAA Guide for Aviation Medical Examiners (based on Title 14 of the Code of Federal Regulations, Part 67) states that for all classes, if there is no impairment, a medical certificate may be issued. Otherwise, disposition requires FAA decision.⁴

The patient was informed of the aeromedical decision and recommendations were made to his aeromedical provider to permanently remove him from flight. In addition, his current health status, that now includes a diagnosis of bilateral lower extremity exertional compartment syndrome, does not meet retention standards for his branch of service. A medical evaluation board was convened to review his ability to be retained as service member.

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