Congenital pericardial cyst in a naval special warfare candidate; Clearance for diving after resection

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ABSTRACT

Introduction: We report the case of a 19-year-old male military recruit who presented for a screening physical for U.S. Naval Special Warfare and Diving Duty. During his screening physical examination, an exophytic pericardial cyst was discovered. Subsequent work-up revealed normal cardiopulmonary function despite this large 7-cm mass, but the candidate was disqualified due to concerns regarding the risk of complications. He underwent successful elective surgical resection without post-operative complications. One year post-operatively, he repeated his cardiopulmonary work-up with normal results and successfully completed training.

Methods: Literature search was conducted using PubMed/Medline. Keywords included pericardial/um, cyst, mediastinum, special operations, military, diving, thoracoscopy/ic resection. Results that included cases of pericardial cysts or other mediastinal tumors were included.

Results: Review of the literature reveals that complications are rare and range widely in severity. Analysis of the physiology of diving, together with absence of reported cases, suggest that there is little to no increased risk in recreational scuba diving for subjects with asymptomatic lesions. While no cases of morbidity or mortality have been reported in elite athletes, the severe and repetitive trauma experienced by Special Operators raises clinical concern for these lesions.

Conclusion: Because of the increased risk of morbidity and mortality in the Special Operations environment, clearance for duty should not be granted those individuals. However, in the general population, as well as with low-impact activities such as recreational scuba diving, periodic observation without resection seems reasonable.

INTRODUCTION

Congenital pericardial cysts are benign mesothelial-cell-lined neoplasms arising from the pericardium itself. Non-congenital etiologies include infectious (e.g., echino-coccal cysts) and inflammatory cysts (secondary to trauma or surgical intervention, pericarditis, effusions that become loculated, as well as pseudocysts). They are generally benign structures that measure from 1 to 28 centimeters (cm) in diameter and are filled with clear transudative fluid (hence the earlier eponym, spring water cysts) [1,2,6].

In the general population, the commonly accepted therapeutic approach is observation in the case of asymptomatic cysts, and thorascopic resection for symptomatic lesions only [1,2,3,4,6].

Infectious, traumatic or inflammatory cysts can present significant morbidity, usually related to their etiology. In contrast, congenital pericardial cysts rarely cause clinically significant symptoms unless they grow to such a size as to cause involvement with surrounding structures, or pose increased risk of rupture. This is more common in the setting of an endophytic pericardial cyst, as opposed to the more common exophytic form, that by definition grows outside the pericardial sac [1,2,6].

Symptoms from larger cysts are generally mild, such as a persistent cough, but complications have been described that include death, cardiac tamponade, erosion of the myocardium, shock, life-threatening hemorrhage and tracheobronchial obstruction [12-23].
The specific dimensions and nature of individual cysts vary greatly and factor into clinical risk assessments.

**Description**
A 19-year-old male presented to the Undersea Medicine Department for routine screening physical examination for Naval Special Warfare duty. He was an asymptomatic male who had previously been a competitive athlete and denied any cardiopulmonary symptoms either at rest or during exercise. His screening electrocardiogram (ECG) showed normal sinus rhythm with a normal rate. On screening chest radiograph (Figure 1, above), he was noted to have some obscuring of the right cardiophrenic angle. Computed tomography (CT) with contrast (Figure 2, facing page) confirmed the finding of a large benign congenital pericardial cyst, measuring 6.7 x 3.5 x 3.4 cm, and having a density of 5 Hounsfield units (nearly the density of water, which is set to be 0, with values ranging from air at -1000 to bone at +1000 HU).

The subject was referred to Cardiology. History and review of systems were unremarkable, and his ECG in clinic showed an asymptomatic resting sinus bradycardia of 51 bpm that resolved with activity. An echocardiogram was performed, and normal left ventricular systolic function was noted, with an ejection fraction (EF) of greater than 55%. The peripheral edge of the cyst was appreciated but not well characterized.

Risk assessment of this patient necessarily took in the rigors of the austere environment and limited medical resources available to the subject. The limited availability of follow-up care for routine surveillance combined with the additional stresses of the Special Warfare and hyperbaric environments were considered (see “Discussion”), and the member was disqualified from military service.

The subject was presented with the options of elective resection versus periodic surveillance. He chose video-assisted resection, which was accomplished through the posterolateral thorascopic approach. The surgery was uneventful, his postoperative course uncomplicated, and he returned to full physical activity without incident. He again sought entrance into the Naval Special Warfare program one year postoperatively.
Upon re-accession to the service, the candidate underwent a repeat medical screen. The interval history and review of systems were otherwise unremarkable, with normal electrocardiogram, spirometry and V/Q scanning, expected postsurgical changes on chest radiograph, and no evidence of cyst recurrence or other cardiopulmonary abnormality on computed tomogram with intravenous contrast. Repeat consultation with Cardiology revealed a normal echocardiogram, with normal left ventricular systolic function, and the candidate was deemed to be low-risk, without sequelae from his surgery. He was cleared for Naval Special Warfare and Diving duties, and allowed to proceed in training, from which he has since successfully graduated. He completed training at Naval Special Warfare Center Coronado, Calif., including successfully completing diving, military free fall, and close-quarter combat training – all without incident.

DISCUSSION – General
In the general population, congenital pericardial cysts are rare, (estimated incidence of 1/100,000, and representing 7% of thoracic neoplasms [1,3,6,10]) and predominantly benign findings that pose little risk to the individual and cause little morbidity or mortality [1-7,10,11]. Complications are rare and range from mild persistent cough and subtle performance decrements associated with gradual impingement on surrounding structures with associated loss of function, to rare but catastrophic rupture of the cyst with resultant shock due to hemorrhage, fluid shift, right ventricular collapse due to pressure release, pericardial tamponade, or pulmonary collapse [12-22]. Although rare, spontaneous resolution has been reported in the literature [24].

The etiology of pericardial cysts varies, and severity of side effects varies accordingly [3,4]. Congenital cysts are rare, show few side effects, and are generally of small enough volume as to pose little risk of rupture. Inflammatory or infectious cysts are more severe in nature, arise from more concerning etiologies that in and of themselves pose additional risks, and should be classified and treated differently from their congenital counterparts.
Physiologic considerations of congenital cysts

While the Law of La Place [8] governs the interactions of pressure on spherical objects, it is inapplicable in this patient’s case, as there should be no expansion of a transudate-filled cyst in a hyperbaric environment. According to Ferguson et al., the change in wall tension from precipitous growth is the primary cause of rupture, and larger cysts were shown to be at increased risk of complications [10]. Thus, for recreational scuba divers, who routinely experience ambient pressures on the order of 4-5 ATA (absolute atmospheres) yet have a primarily non-stressed experience, there ought to be little risk for significant complications. Moreover, given the slow production of transudates, the cyst should not rapidly increase in size secondary to diving-induced central shifts in peripherally pooled blood [8,9]. Thus, significant shear stresses should not result. Similarly, were the diver to be subjected to an uncontrolled ascent, the resultant pressure change would not likely affect the incompressible cyst. Significant shear stress would most likely arise in the event of cystic adhesion to adjacent pleural or pericardial membranes. As per Krasna et al. in 1996, while positive radiographic findings of adhesions had a 66% correlation on thoracoscopy, a negative CT had no correlation; thus a negative study would not mitigate the above risk in light of such a poor negative predictive value [32].

Special populations

In the operational environment, access to medical care may be limited. Evacuation times may exceed the minutes-to-hours time frame required in an emergency such as that described above. Moreover, in a hostile environment wherein each member plays a key role, an injured member presents a liability in terms of mobility and operability that is unacceptable. Given the increased risk of thoracic trauma to be expected in this specialized population (parachuting, combat-induced trauma, high-speed decelerations), this presents a far more real risk for cyst rupture, and an independent risk factor in its own right. The closest civilian corollary would be elite athletes, but while there are no case reports of pericardial cyst rupture in elite athletes, there are two cases reported where resection was pursued pre-emptively in those whose occupations subjected them to frequent or severe trauma [24].

Resect vs. Observe?

The key questions for the clinician are as follows: a) is this condition of concern for my patient? and b) is the risk-benefit ratio of the therapy in favor of intervention or observation?

Based on the review of the relevant physiology, recreational scuba diving does not present a significant concern, whereas military special operations do. With respect to the second question, the incidence of complications for all thoracoscopy is between 4.3% and 7.5% [32-34] without differentiation based upon the indication for surgery. This compares to the “low incidence of serious complications” produced by pericardial cysts, and has led to the practice of observing asymptomatic extrapericardial cysts in the general population [24-29].

Several previous experts have taken exception to this recommendation, notably Mouroux et al. in the case of large asymptomatic lesions, echoing the observation of Ferguson et al. noted previously. Mouroux et al. went on to add that activities that increase the risk of rupture should also be considered to be indications for resection [24]. Takeda et al. advocated for resection even in asymptomatic cases. This is based on clinical unpredictability, despite the acknowledged benign nature of most asymptomatic congenital lesions [12].

As observed earlier, symptoms vary widely at presentation, and are predominantly mild in nature. This, in combination with the fact that most are incidental findings [24,25] has led to the conclusion that pericardial cysts are best managed expectantly [12,25]. Moreover, each of the above references present cases wherein the lesion was either symptomatic, or resected due to concerns for malignancy. There are no long-term observational studies that help to define the natural history of the asymptomatic cyst.

To the contrary and as noted previously, observed outcomes of expectantly managed cysts range from spontaneous resolution to rupture. Accurate calculation of the true incidence of complications is impossible due to the fact that most asymptomatic cysts may persist without detection for years. Certainly, the type and level of the patient’s intended activity must be considered. While clinical decision-making prompted resection in two cases described by Mouroux et al. [24] (because the subjects in question actively participated in scuba diving and martial arts), there is no case-controlled randomized evidence to support this.
Rationale for work-up
Currently accepted standards for screening of divers, both working (commercial and military) and recreational, discourage clearance for diving in cases of structural or arrhythmic heart disease [8,9]. However, aside from indirect references pertaining to functional status and cardiovascular risk stratification, no mention is specifically made of pericardial cysts. In the postoperative work-up of this patient, ECG, Cardiology consultation and echocardiography were used to assess for cardiac structural integrity and arrhythmia that may have arisen due to changed anatomy due both to the pathology as well as from postoperative complications. Chest CT was performed for recurrence, visible adhesions, and anatomic relationships. Spirometry assessed pulmonary function, and V/Q scanning evaluated for air-trapping. Specifically, the pulmonary function was of great concern, due to the potential for postoperative adhesions to cause pleural fibrosis or segmental sequestration due to entrapment by adhesions.

The dual-pronged approach of testing with imaging to assess for structural changes and functional testing was of particular concern due to the potential for central changes in airflow in the lungs and the risk to the patient from arterial gas embolism or pulmonary overinflation syndrome (POIS) should air-trapping develop, especially given the poor negative predictive value of CT alone [32]. It must be mentioned that minimally invasive approaches notwithstanding, there is a risk of adhesions or other postoperative complications that may compromise cardiopulmonary function. Patients should be counseled preoperatively that even a successful procedure may leave them with activity restrictions.

Limitations to firm recommendations are due to the relative rarity of the condition, minimal data on the rate of complications and their severity in asymptomatic cysts, the rarity of comprehensive pre-participation diving examinations for recreational divers, and the large degree of selection bias toward healthy individuals present in the special populations such as elite athletes, military service members and the Special Operations community.

CONCLUSIONS
Pericardial cysts, while rare, have been well characterized, and common practice is to observe asymptomatic extrapericardial cysts [1,10]. Although the risks associated with congenital pericardial cysts are low and differ from those of infectious or inflammatory cysts, they can pose unacceptable risks in special populations.

It appears that the majority of complications occur in cysts that undergo size change [10]. For recreational divers, the low level of mechanical stress upon a cyst would support observation with strict counseling of the risks and benefits to the patient. Exposure to hyperbaric pressures does not physiologically justify intervention as an independent factor, nor are there cases present in the literature reporting adverse outcomes in divers.

In the tactical setting, the potential risks of adverse complications rise in both frequency and severity due to the remote settings and occupational hazards. Review of the published case reports yields insufficient data to make a firm recommendation on better than expert opinion, but comparison with the low risk of complications of minimally invasive surgical resection suggests that elective resection is reasonable in those who are occupationally subject to severe or repeated trauma or in whom complications would present unacceptable risks.

In recreational (non-technical) divers, it seems reasonable to permit diving with close follow-up, but we support the continued recommendation against clearance for military special operations training [8,9]. In cases where elective resection is pursued, thorough postoperative evaluation is recommended, but clearance for diving and for Special Operations may be granted in asymptomatic individuals with good outcomes after uncomplicated surgery and with demonstrated return to normal physiologic function.

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