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VIEWPOINT

Remoras and Spontaneous Echocardiographic Contrast

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Abstract

The term "Remora" (hindrance) – re (again)/mora (delay) -originally designated a family of fishes – the suckerfishes. In ancient Greece and Rome and up to the early 19th century, these fishes were believed to slow down ships by attaching to them. Medicine adopted the term "remora" to describe fluid/blood stasis. Intracardiac blood stasis, or remora, especially in the left atrial appendage, is associated with thrombogenesis and responsible for cardioembolic phenomena. The slow and swirling movement of blood causes the appearance of spontaneous echocardiographic contrast (SEC). I briefly narrate the Naval Battle of Actium, whose result was mythically attributed to the remora fishes, and make a short review of remoras. I also describe Laennec's discussion about intracardiac blood stasis and give a short account of SEC, its original descriptions and importance.

Introduction

Atrial fibrillation (AF) is associated with an increased risk of embolism to the brain and other sites. The risk is even greater in the presence of evident decrease in blood flow velocity in the left atrial appendage (LAA), a common feature of many conditions such as AF and mitral stenosis. Echocardiography can show the presence of blood stasis, or "remora", strongly correlated with an intracavitary smoky appearance, known as spontaneous echocardiographic contrast (SEC) (Figure 1).[1]

Keywords

Cypriniformes (remoras); Atrial Appendage; Embolism and Thrombosis; History, Ancient; Diagnostic Imaging; Ultrasonography/history; Echocardiography/history.

The term *remora* designates a family of fishes (shark suckers) known for their ability to adhere to large fishes and mammals using a specialized sucking structure. I describe why these fish were so-called "remora" in the first place, and why Cardiology has borrowed this term to describe the phenomenon of blood stasis.

The battle of Actium

Actium is a promontory in Acarnania, Greece. It occupies the southern side of a strait connecting the Ionian Sea to the Ambracian gulf. Octavian, later known as Augustus (27 B.C.), defeated Mark Antony and his allied Egyptian forces in a great naval battle there (September 2, 31 B.C.). The battle became the decisive confrontation of the Final War of the Roman Republic.

Antony's infantry was outnumbered (maybe 70,000 vs. 80,000 men) and Octavian had blocked Antony' s communication with Egypt via the Peloponnese. By following Cleopatra's advice, Antony moved his larger, heavily armed but less maneuverable fleet (500 vessels including the Egyptian forces). Cleopatra's fleet followed in the rear, but never entered in the battle. Octavian's fleet (250-400 warships) was mainly composed of lighter but well-equipped ships. Also, his crews were better trained and in better health, since Antony's soldiers had been struck by malaria before the confrontation.

The battle raged outside the gulf of Actium for many hours. Desertion of Cleopatra's lighter warships when the winds blew in the right direction decisively influenced the battle's result. Antony managed to catch up with Cleopatra but left the remaining of his fleet behind, which then surrendered to Octavian and his admiral Agrippa.[2]

Antony's land forces surrendered in the following week. Several battles followed during the following year and led to Octavian's final victory. Antony and Cleopatra VII committed suicide in 30 B.C. (July 31 and August 12,

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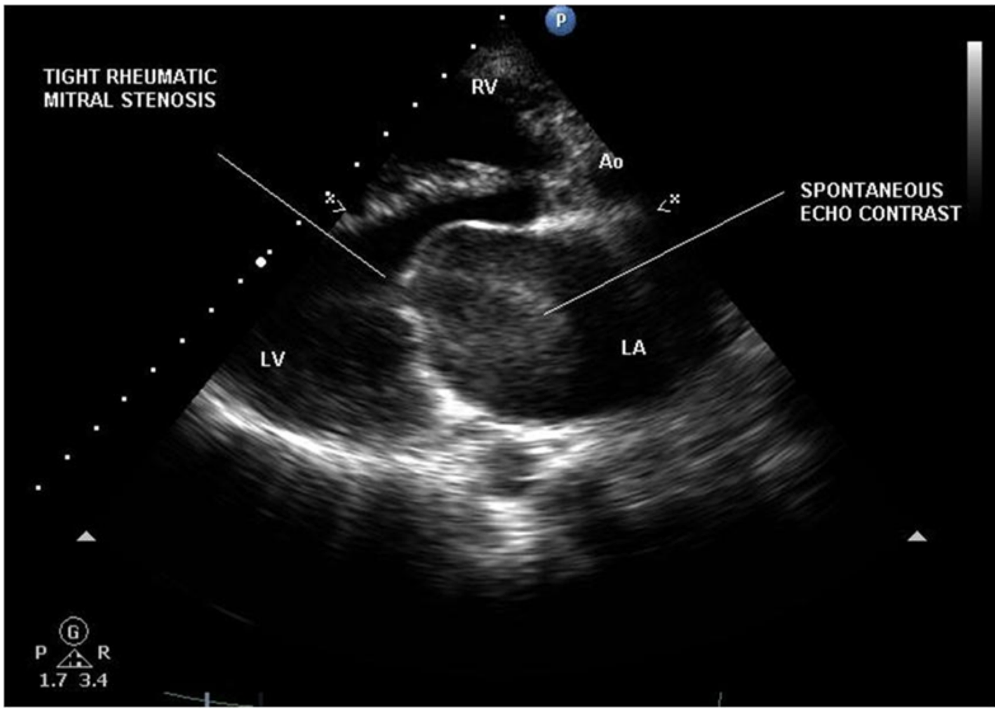

Figure 1 - Echocardiogram, parasternal axial view. Blood stasis (remora) appears as spontaneous echocardiographic contrast in a patient with tight mitral stenosis and atrial fibrillation. Also, note the "hockey stick deformity" of the anterior leaflet (upper part), and left atrial enlargement. Image posted by Jayachandran Thejus, MD, in http://www.heartpearls.com/category/interesting-echocardiographic-images/page/2

respectively). Octavian's power was then consolidated, and this opened the avenue to Rome's transition from Republic to Empire.

The myth

Antony's heavy and less maneuverable galleys behind the Egyptian fleet proved slow in the battle, and their defeat by Octavian substantiated the Remora myth. After describing the Actium battle and a similar episode involving the emperor Caligula, the naturalist and historian Pliny the Elder (23-79 CE) stated that all species of remora had the same property, adding an ancient Greek episode (Nat. Hist. 2, XXXII, 1).[3]

The false belief persisted for many centuries. In 1580 Michel de Montaigne (1533-1592) translated two episodes described by Pliny (author's translation from *Essais*, II, xii - pp.200-2): "Many believe that in that final and great battle in which Antony was defeated by August, Antony's galley was slowed by this tiny fish that the Romans call *Remora*, because of its property of slowing down every kind of ship to which it attaches. The Emperor Caligula, sailing with a large fleet by the Roman coast, was the only to have one of his ships slowed down by this same fish; once he detached the fish from the hull, the emperor got disappointed as he realized that such a tiny little animal could defy the sea, the winds and the strength of the oars by fixing its body to the ship only by its "beak" (in fact, it is a crustacean). He was also astonished, not without reason, by the fact that, inside the boat, the animal did not exhibit the same strength as it did outside the boat".[4]

The 1828 first edition of the Webster dictionary (http://webstersdictionary1828.com/) still defines remora as a fish "said to attach itself to the bottom or side of a ship and retard its motion". At the end of the 19th century, however, the mythic nature of their effect of slowing down ships was already well recognized. In 1893, for instance, the definition in the Larousse Dictionary was: "*poisson auquel on attribuait le pouvoir d'arreter les navires*".

Remora fish

Suckerfishes constitute a family (*Echeneidae*) of ray-finned fishes that measure up to 75 cm long. Their first dorsal fins take the form of an oval slat-like structure with flexible membranes with thousands of spicules that increase friction forces (Figure 2a). This structure can generate suction and attach firmly on the smooth skin of large fishes – sharks, rays, tuna, swordfishes - and other animals such as dolphins, whales, dugongs and manatees, turtles etc. (Figure 2b). They can also attach themselves to boats and ships. Sliding backwards increases the negative pressure and suction and moving forward allows detachment from the surface and free swimming.

Remoras and their hosts live in commensality. Remoras eat the host's feces, leftovers, parasites and clean epidermal sloughing, whereas hosts confer protection, transport, promote fast passage of fluid through the gills and hence passive ventilation and energy sparing.

The term Remora is derived from the Latin (Hindrance; to defer, delay, linger) and is a composite of *re* (back, again) and *mora* (delay). The family name – *Echeneidae* (1810) – also refers to the mythic property of this fish (*Echein* – to hold, possess; and *Naus* - ship). Evidence of any deleterious hydrodynamic effects of the attachment of remoras to fishes or ships is, however, scarce or absent. Additional effort from hydrodynamic strain and metabolic demand for food imposed by the attachment of remoras to large fishes or dolphins are minimal (*circa* 1%), even at high speed (e.g., 500 cm/s). This, however, depends on the number of remoras attached and the size of the host.[5]

Remora as blood stasis

Cardiac blood stasis and its thrombogenic potential have been described for a long time. René Théophile Hyacynthe Laennec (1781-1826), who made extensive autopsy studies of his patients, does not refer to it in the first edition of his treatise on auscultation and lung and heart diseases (1819). However, he clearly mentions "*la stase du sang*" in Chapter XIX (*De l' inflammation de la Membrane Interne du Coeur et des Gros Vaisseux*, pp. 598-618) of the expanded and even more influential second edition of the *Traité* (1826).

The term *remora* was already in use in the 19th century to describe biological fluid stasis. As for intracardiac blood, the above text (the *Traité*, 1826) was translated into English by John Forbes (p. 663), as follows: "From all previous reports I believe we can draw the following conclusions – 1. Remora of the blood, in consequence of obstruction to its flow, is sufficient to produce coagulation, and to determine the formation of a coagulum of organizable fibrin. All causes capable of occasioning remora, particularly mechanical obstruction to circulation and repeated and prolonged episodes of syncope, seem to me sufficient to produce this effect".[6]

Spontaneous echocardiographic contrast

In 1975, Feigenbaum, using M-mode echocardiography, described left intracavitary echoes near dyskinetic segments of the left ventricle and thrombi in patients with coronary artery disease. Human and animal studies using real-time two-dimensional echocardiography confirmed that these variables – density and conformation echoes – moved in slow circles and were due to the sluggish blood flow caused by severe wall motion abnormalities,[7] which could be found even during anticoagulation treatment and were also detected within abdominal aortic aneurysms. These echoes "resembled smoke moving slowly through a light beam in a dark room".[7] Increasing layering and alignment of red blood cells (*rouleau*) in low-flow and whirling conditions are responsible for the increased echogenicity.[7]

Iliceto et al. first described dynamic intracavitary echoes – defined as a cloud of low-intensity echoes slowly moving in a circular or spiral shape – in the enlarged left atrium of 10 patients with severe mitral stenosis and AF.[8] At that time, correlation of SEC with thrombogenesis was already well established.

Most thrombi in patients with AF (90%) or mitral stenosis (60%) are detected in the LAA.[1] SEC is also most commonly seen in this structure. In the setting of stroke of unknown etiology, the presence of SEC in the LAA indicates a probable cardioembolic origin, even in the absence of thrombus.[9] LAA is an important contractile and multilobulated structure, whose dysfunction is the main cause of clot formation in AF, mitral stenosis, myocardial stunning after cardioversion, etc. SEC and thrombi are more frequently detected in patients with LAA contractile dysfunction.

A comprehensive study of the LAA is currently performed using transesophageal echocardiography including multiple imaging planes, pulsed wave-Doppler and tissue strain techniques.[1,10] These techniques provide an accurate analysis of LAA's contractile properties and demonstrate good correlation with the presence of SEC or thrombus and with thromboembolic risk.[1,11]

Conclusion

Thrombogenesis in FA and other conditions with slow atrial flow involves the complex interplay of

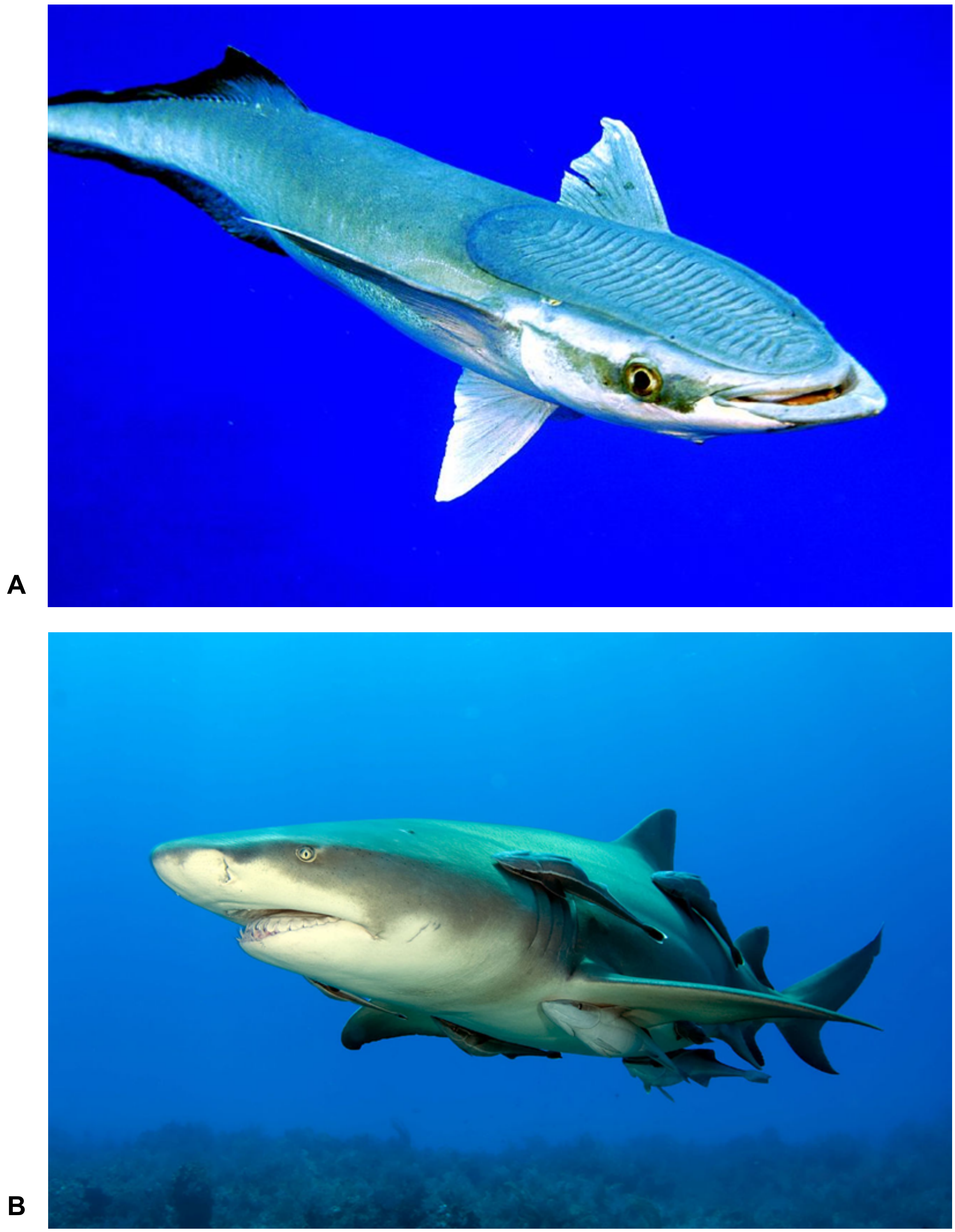

Figure 2 - The *Remora* (*Echeneidae*). A. *Echeneis naucrates*. The dorsal suction pad and the projecting lower jaw are shown. B. Remoras of varied size firmly attached to a large shark. http://www.realmonstrosities.com/2012/12/remora.html

blood stasis, increased extracellular matrix turnover, progressive morphological changes and endothelial lesion of the LAA, as well as changes in soluble blood components, such as fibrin D-dimer, and prothrombin fragments.[12] Mechanisms of these processes involve increased activity of the renin-angiotensin system and production of growth factors (especially VEGF), and impaired production of endothelial nitric oxide. Many other factors (age, hypertension, low cardiac index etc.) may additionally increase the risk of thrombogenesis and hence embolism.[12]

The word "remora" has been associated for centuries with the slow flow of many fluids, including blood. Intracardiac remora leads to the appearance of SEC in echocardiography and is strongly associated with thrombogenesis and an increased embolic risk. After all, remoras are not responsible for delaying battle ships; however, their connection to cardiology holds strong.

Author contributions

Conception and design of the research: Andre C. Acquisition of data: Andre C. Analysis and interpretation of the data: Andre C. Writing of the manuscript: Andre C. Critical revision of the manuscript for intellectual content: Andre C. Supervision / as the major investigador: Andre C.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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