Rheumatic fever, endocarditis, and heart valves

Objectives:

1. Understands the clinic pathological features of rheumatic heart disease, which is a major cause of acquired mitral and aortic valve diseases in the Kingdom of Saudi Arabia.

2. Know the pathological causes and pathophysiological consequences of stenosis and incompetence of all the cardiac valves but particularly the mitral and aortic valves.

3. Understands the pathology of infective endocarditis to be able to identify patients at risk and when appropriate ensure prophylactic treatment is given.

Revised by
شوق الأحمري & طراد الوكيل

Black: Doctor's slides.

Red: important!

Green: Doctor Ammar notes.

Grey: Extra.

Bold black: New terminology.

Female Slides only

Rheumatic heart disease

https://www.youtube.com/watch?v=cXPtewa5PJc&index=7&t=23s&list=LLhph2500OUDsKDIf2o-pH0A

Rheumatic heart disease is a heart disease caused by rheumatic fever.

Rheumatic heart disease can be acute or chronic.

Acute Rheumatic fever (RF)

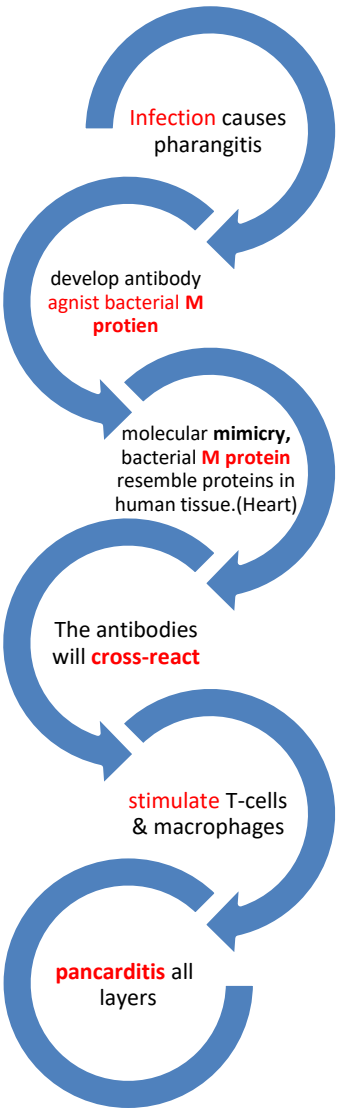
It's an acute immunologically mediated, multi-systemic inflammatory disease that occurs after Group A Beta Hemolytic Streptococci. Which is consider as non-suppurative[1] inflammatory disease with cardiac and extra cardiac (e.g. Skin, CNS, joint) manifestation.

- Systemic complication of Pharyngitis or Tonsillitis due to Group A Beta Hemolytic Streptococci.
- Usually affects children (5-15 years).
- 2 - 3 weeks after an episode of Streptococcal pharyngitis*
  only 3% of them may show the signs and symptoms of rheumatic fever
- Although it's associated with inflammation of ALL parts of the heart, Valvular inflammation and scarring produces the most important clinical features.
- Rheumatic fever is different from rheumatoid arthritis.
- Rheumatic fever is the most common cause of valvular Disease[2].
- It is the only cause of acquired Mitral valve **stenosis**[3]
- Valvular diseases are very common especially in third world countries.

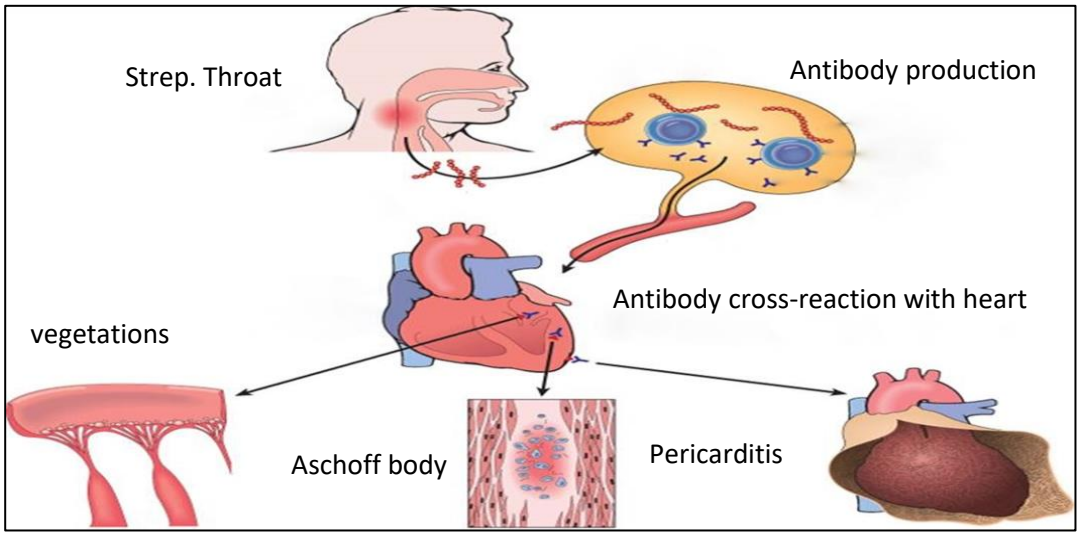
*Why do we need this period? We need it allow the immunological reaction to occur.

PATHOGENESIS

- Acute rheumatic fever is an immunological (hypersensitivity) reaction caused by molecular mimicry; bacterial M protein resemble proteins in human tissue.
- There are similar proteins found in the *(joints, skin, synovium, endocardium, myocardium)*, because of that the antibodies will get confused & start (**cross-react**) attacking those organs.
- So, the body when he has an infection he start forming anti-bodies and cell mediated immunity against these structures, (it will form anti-bodies against **M protein**).
- Antibodies will binds to these protein that is found in myocardium and the **cardiac valves** → stimulation of T-cells (CD4 Cell) & activation of complement and Fc Receptor-bearing including macrophages → **Pancarditis** (inflammation in all layers of heart).



[1] Pertaining to inflammation without the production of pus.
[2] disorders of the heart valves
[3] narrowing of valve opening, almost always due to valvular abnormalities such as (calcification, scarring) which makes it harder to push the blood forward "obstruction of blood flow"

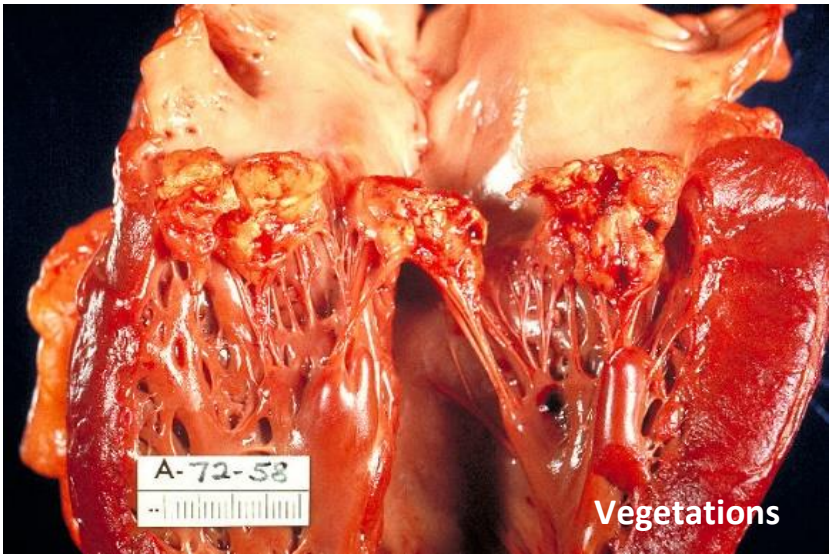


MORPHOLOGY:

Rheumatic fever causes **pancarditis**[4], and **Aschoff bodies** can be found in any of the three layers of the heart—**pericardium**, **myocardium**, or **endocardium** (including valves).

- **Pericardium***: exhibits a fibrinous exudate (which generally resolves without sequelae[5]).*

Fibrinous or serofibrinous secretion in the pericardium. These secretions collect between the visceral and parietal pericardium like butter between two slices bread and therefore also called "bread and butter" pericarditis.



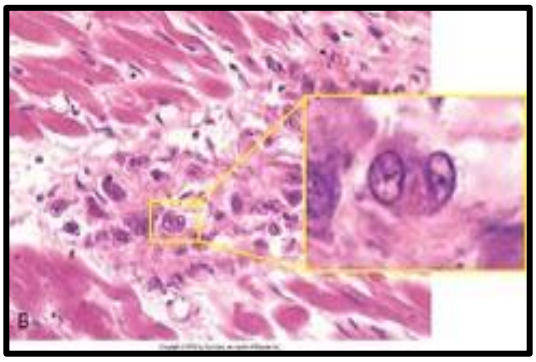
- **Myocardium:** ***many*** *Aschoff bodies (within the interstitial connective tissue). Can cause sudden death.*
- **Endocarditis**: *inflammation of the endocardium including the heart valves (valvulitis) - **Mitral** valve is involved more commonly than the **Aortic** valve- and **chordae tendineae**. It results in fibrin deposition on valve leaflets forming tiny, pale thrombi along lines of closure called rheumatic **vegetations**[6] (cause little disturbance in cardiac function).*
- **Subendocardial lesions can also be seen, commonly in left atrium called as (Maccallum plaques).** مهم

This acute inflammation may either resolve completely or progress to scarring with development of chronic fibrotic deformities of the heart **valves** and **chordae tendineae** leading to Chronic rheumatic heart disease many Years later.

[4] Inflammation of all three layers of the heart
[5] مضاعفات

[6] In medicine, a **vegetation** is an abnormal growth named for its similarity to natural vegetation. Vegetations are often associated with **endocarditis**

Aschoff bodies (Nodules):



Aschoff bodies

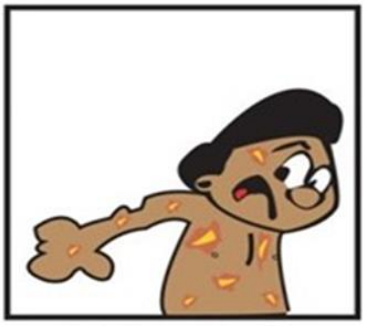
These myocardial inflammatory lesions are collections of:

- **Focus of collagen necrosis (Focus of eosinophilis collagen)** (representing the site of antibody-antigen reaction)
- Inflammatory cells (Lymphocytes &Plasma cells.
- Activated macrophages called **Anitschkow/caterpillar cells cells). Some of the macrophages become multinucleated to form Aschoff giant cells.**

- **The** characteristic lesion of acute rheumatic fever are the Aschoff bodies.
- **Aschoff** bodies are multiple tiny granulomatous lesions of the heart. They are situated next to small arteries and are characteristically seen in the myocardium (rheumatic myocarditis).
- Aschoff bodies are found mainly in the myocardium and pericardium. Uncommon in the endocardium and heart valves.
- They ultimately "heal" by fibrosis resulting in a nodule of scar tissue.

Extra cardiac manifestations of Rheumatic Fever: (Involvement of Other Organs)-it is also the Jone's major criteria-

- **Joints:**
  - Arthralgia[7]
  - Migratory polyarthritis, which is "fleeting arthritis" in the large, joints e.g. knee, ankle, elbow wrist etc. It is self-limiting with no chronic deformities. Aschoff bodies may be present in the synovial membrane, joint capsule, ligament etc. with joint effusion.
- **Skin:** skin nodules, erythema[8] marginatum[9].**
- **Subcutaneous tissue:** Rheumatic nodules mainly seen over the bony prominences e.g. knuckle, elbow, patella etc.
- **Neurological disorder:** Sydenham's chorea (St. Vitus' dance) characteristized by series of rapid involuntary purposeless movements of the face and arms. This occurs late in the disease.
- **Lung:** uncommon, chronic interstitial inflammation and fibrinous pleuritic.



[7] Pain in a joint.
[8] Abnormal redness of the skin due to capillary congestion.
[9] Type of erythema involving pink rings.

CLINICAL FEATURES

- History of sore throat: symptoms start 10 days - 6weeks after group A beta Hemolytic Streptococcal pharyngitis
- **Throat swap cultures are** negative for streptococci at the time of symptom **onset**, but Serum **antistreptolysin O** (ASO titer/ antibodies to group A streptococcal antigens), **anti-DNAase B**, and **antihyaluronidase** are raised and provide evidence of a recent infection with group A Streptococcus.
- Acute symptoms usually subside[10] within 3 months
- The diagnosis of acute rheumatic fever is made based on serologic evidence of previous streptococcal infection in conjunction (at the same time) with two or more of the so-called *Jones criteria*:

Jone's criteria[11]

- **MINOR criteria** are non-specific signs of inflammation including.

-Fever **-Previous rheumatic fever**

-Lab tests indicative of inflammation: **Elevated ESR** (erythrocyte sedimentation rate), C - reactive protein (CPR), and **Leukocytosis** (increase neutrophils count)

-Arthralgia[12] **-ECG changes**. (Prolongation of PR segment)

- **MAJOR criteria**
  - **Migratory polyarthritis**[13] , swelling and pain in large joints " knee , ankles , wrist "
  - **Pancarditis** " inflammation of the all the heart layers including " endocarditis , pericarditis , myocarditis , *in female slide it's*:

Carditis (murmurs, pericardial friction rubs ,weak heart sounds, tachycardia and arrhythmias cardiomegaly ,pericarditis ,and congestive heart failure).

- **Subcutaneous nodules (Rheumatic nodules)**
- **Erythema marginatum*** , a RASH which charictrazied by very red border or margins.
- **Sydenham chorea****[14]: (St. Vitus' dance) → causes involuntary movements of the musculoskeletal system, behavioral and personality changes (it is very rare now).

-When the patient has either:
1. **One** major criteria and **two** minor criteria
2. **Two** major criteria **without** minor

We can say he has **rheumatic fever**.

Acute attack usually resolves, but may progress to chronic RF; **repeat** exposure to group A beta Hemolytic Streptococci result in relapse of the acute phase& increase risk for chronic disease.

** https://www.youtube.com/watch?v=tkwzJiikgRk&index=6&list=LLhph2500OUDsKDIf2o-pH0A

[10] تهدأ/تخمد

[11] is a collection of symptoms and sings to identify rheumatic fever from other diseases. And it's include MAJOR and MINOR sings.

[12] ألم مفصلي

13 . one large joint after another becomes painful and swollen for a period of days, followed by spontaneous resolution with no residual disability.

14 Sydenham chorea: dancing syndrome داء الرقص

Chronic rheumatic heart disease:

The myocarditis and pericarditis components of RF typically resolve without permanent sequelae. In contrast, the acute valvulitis or chordae tendinitis of rheumatic fever heals by fibrosis (scarring) and result in irreversible deformity of the involved cardiac valve and chordae tendineae. Severe valvular scarring develops months or years after acute RF.

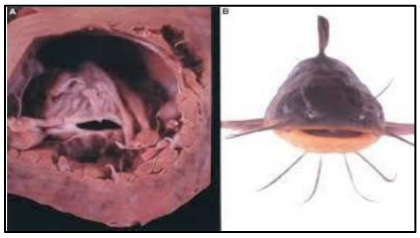
- **Repeated attacks or a single severe first attack can cause chronic rheumatic heart disease leading to congestive cardiac failure.**

Characterized by organization of the acute inflammation and subsequent scarring.

1. Aschoff bodies replaced by fibrous scar (*so Aschoff bodies rarely seen in chronic rheumatic heart disease*).
2. **Mitral** (*sometimes **Aortic***) **valves** exhibit:
   A. **Leaflet** (cusps) thickening due to fibrosis. (Stenosis –reduction of diameter-)
   B. Thickening and fusion of the **chordae tendineae** due to fibrosis. (Regurgitation –improper closure-)

This will result in deformity in the valves, and it will causes:

1. **Stenosis** -using the Stethoscope you will hear Murmur- of the valves "**fishmouth stenosis** as a result of calcification of fibrous tissue".
2. **Regurgitation**:
   A. **Mitral valve**→ Blood will flow back from ventricle to atrium during contraction.
   B. **Aortic valve** → Aortic regurgitation towards the left ventricle.



Rheumatic fever like to affect:

-***Mitral*** **valve** alone is the most affected (**bicuspid**) (**70%** or 50%).

-Followed by combined *mitral/aortic* valves (25%)

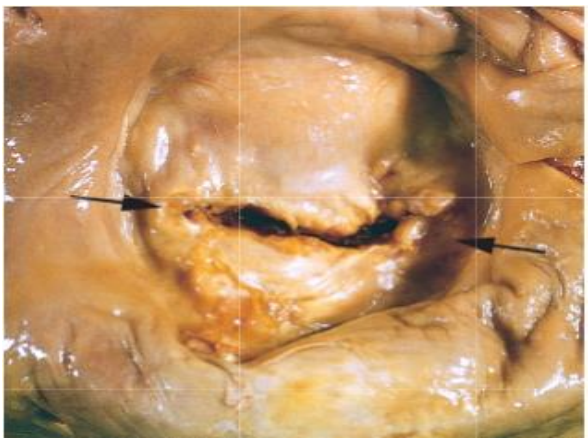
-VERY rare in ***tricuspid*** (5%).

-It never (or very very rare) affect ***pulmonary*** **valve**.

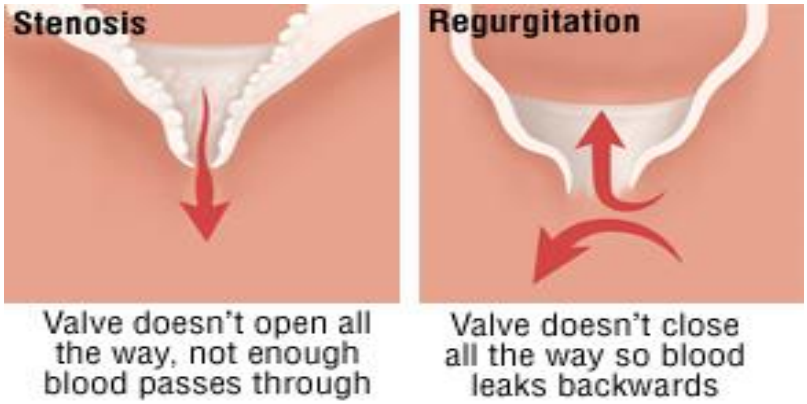
If a patient 19-year-old female came to you with systemic arterial embolism, you **should first** think that she has Rheumatic fever**. No** arthrosclerosis because she is young.

-Most harmful effect of rheumatic disease is due to involvement of cardiac valves. The valve leaflets develop diffuse fibrosis, become thickened, shrunken, and less movable which can lead to cardiac failure, thromboembolism and infective endocarditis.

Aschoff bodies >> inflammation >> fibrosis >> valvular induration >>> **deformity of the valve**



Mitral Stenosis



Clinical features

Manifests years or decades after the initial episode of rheumatic fever.

- Signs and symptoms depend on the valve(s) involved:

Cardiac murmurs, hypertrophy, dilation, congestive heart failure, arrhythmia, thromboembolism and infective endocarditis.

- Treatment: may require valve surgery.

Complications of Rheumatic Fever:

- ***Damage to heart muscle:*** The inflammation associated with rheumatic fever can weaken the heart muscle, resulting in poor pumping function.
- ***Mural thrombi*** form in cardiac chambers. They give rise to **thromboemboli**, which can produce infarcts in various organs
- ***Congestive Heart failure***: an inability of the heart to pump enough blood to the body
- ***Left atrium hypertrophy*** *seen by x-ray or CT-scan* causes **atrial fibrillation** →stagnation of blood → forming blood clot (thrombus) →could cause brain stroke or heart failure.
- ***Bacterial infective endocarditis:*** The scarred valves of rheumatic heart disease provide an attractive environment for bacteria to grow.
- ***Adhesive pericarditis.***

-we told you that the rheumatic fever and in cases of mitral stenosis the left atrium become big (dilated)

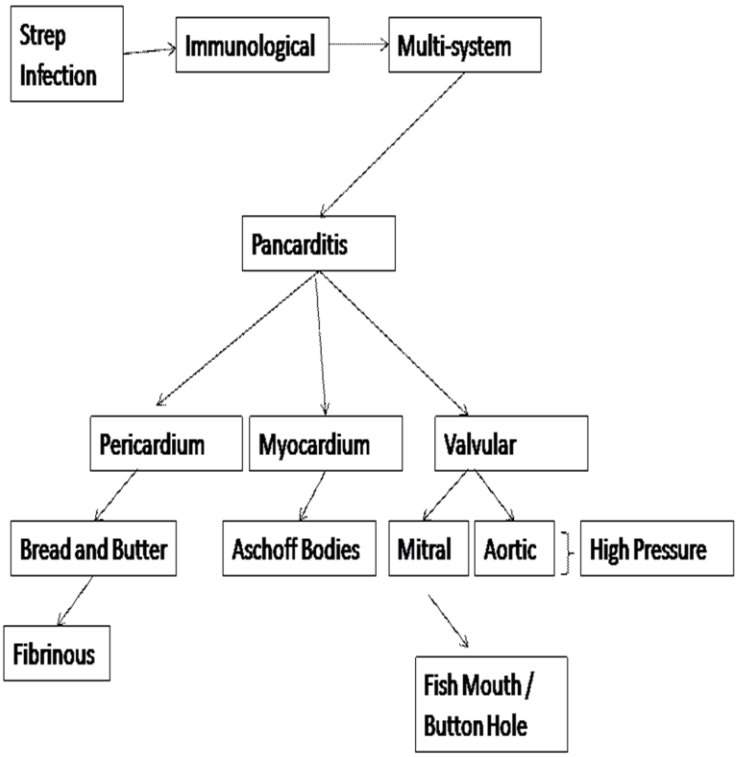
-why become dilated? Because it cannot empty itself from the blood

-why it cannot empty itself from the blood? Because there is regurgitation or stenosis or both.

When we say mitral valve disease that means it has both stenosis and regurgitation at the same time

-when the atrium become big there will be stasis of the blood (ركودة دموية) and any disease which is associated with stasis predispose to the thrombosis and therefore the patient will have thrombi

atrial fibrillation بيكون عندهم → Because it cannot Contract very well



INFECTIVE ENDOCARDITIS (التهاب الشغاف)

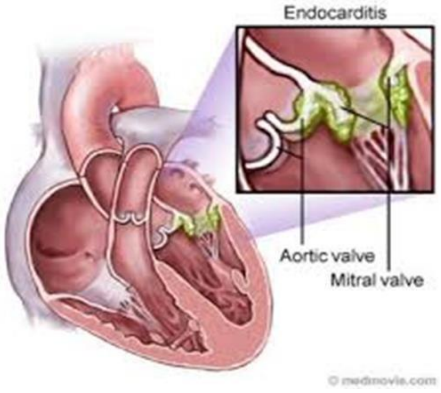
https://www.youtube.com/watch?v=kW-85yk0ErQ&index=5&list=LLhph2500OUDsKDIf2o-pH0A

- It's an infection of the endocardium lining the cardiac valves or mural surface (الجدار السطحي). Resulting in the formation of an adherent mass of thrombotic debris and microorganisms.
- the Mitral valves is most common sites followed by aortic valve
- In IV drug users, the right side valves like the tricuspid are more commonly involved.

Classification of endocarditis:

- ***Acute endocarditis:***
  - Caused by a highly virulent organism
  - Attacking normal valve
  - Staphylococcus aureus in (50% of cases).
  - Progresses rapidly
  - Prognosis is very bad
  - Has little local host reaction.

Very severe, mainly affect I.V drug abusers. It could cause septicemia



- ***Subacute endocarditis:***
  - caused by a low virulence organism (because there is a weak area already)
  - attacking abnormal heart
  - Progresses slowly
  - streptococcus viridians (more than 50% of cases)
  - it induces a local inflammatory reaction
  - most patients recover after antibiotic therapy

Prognosis: depends to some extent on the offending organism and the stage at which the infection is treated. A third of cases of S. aureus endocarditis are still fatal.

-Usually when the person **has rheumatic heart** disease, we should look to his teeth and mouth health, especially when he has **caries** (تسوس الأسنان).

-Because if has caries with rheumatic heart disease he should repair all his teeth (لأنها بؤر للانفكشن).

In addition, any time he is going to have tooth extraction we should give him antibiotics before (prophylactic antibiotics) to **prevent subacute endocarditis** which could be lethal. It is very dangerous, it causes **septicemia** (تسمم في الدم).

Clinical features

- **Fever**, fatigue, weight loss and chills.
- **Cardiac murmurs.**
- After 6 weeks: splenomegaly, petechiae, and clubbing of the fingers.
- Positive blood culture for the organisms (only minority of cases remain negative).

Risk factors:

- **In children:** an underlying cardiac lesion (congenital heart disease is most common).
- **In adults:** More than half of adults with bacterial endocarditis have no predisposing cardiac lesion. Mitral valve prolapse and congenital heart disease are the most frequent cause for bacterial endocarditis in adults.
- **Rheumatic heart disease**
- **Intravenous drug abusers** can end up injecting microorganisms intravenously when taking intravenous drugs, leading to IE. The **tricuspid** valve is infected in half of cases. About 50% of the IE in IV drug abusers are caused **by S. aureus**.
- **People with prosthetic valves** are at high risk of developing IE. Prosthetic valve endocarditis is caused commonly by coagulase-negative staphylococci (e.g. S. epidermidis).
- **Transient bacteremia from any procedure may** lead to infective endocarditis e.g. dental procedures, urinary catheterization, infected indwelling vascular catheters gastrointestinal endoscopy, and obstetric procedures.
- **The elderly** (due to degeneration of heart valves e.g. calcific aortic stenosis), **diabetics and pregnant women are at increased risk.**

Complications:

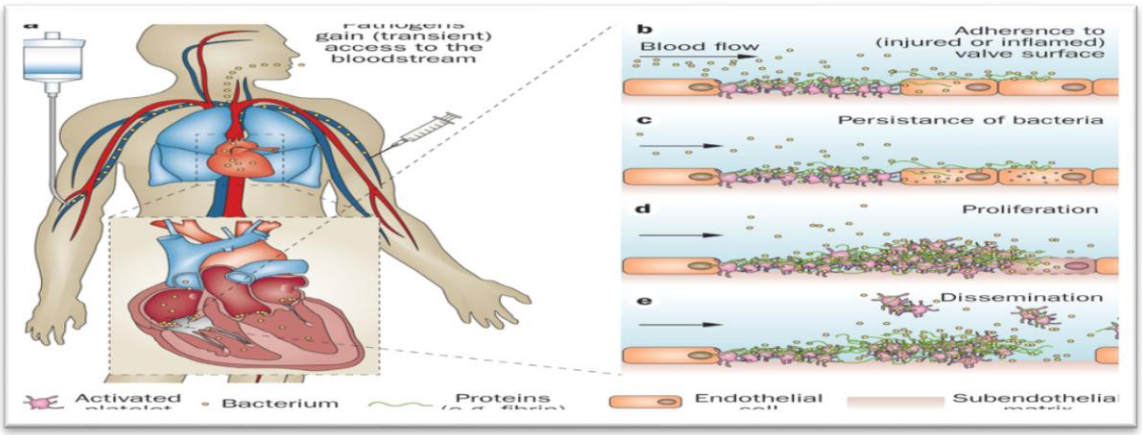
- valve **ulceration** and perforation, rupture of chordae tendineae,
- **Arrhythmias**, valvular regurgitation and congestive heart failure (due to destruction of a valve).
- **Septicemia** or **septic systemic embolization** of infected vegetations which travel to multiple sites, causing in farcts or abscesses in many organs (e.g. neurologic deficits due to **embolization* to the brain** or infarcts of the myocardium due to embolization to the coronary artery).
- **Pulmonary emboli** is seen in **tricuspid** valve/ right sided endocarditis e.g. IV drug addicts.
- **Mycotic/infected aneurysms of vessels**
- **Renal failure**

Part of these vegetation detach and it goes with the stream everywhere (to the brain, lung or anywhere), also maybe goes to the skin (subcutaneous) and it causes nodule in fingers we call it Osler node or maybe other lesions we call it janeway lesions. Sometimes it can go to the glomeruli and cause glomerulonephritis*.

شرح من الدكتور : اذا ذهبت لل glomeruli تسبب ال glomerulonephritis لأنها تسوي immune complexes وتتجمع هذه الكومبليكسز في ال glomeruli لأنها highly vascularized organ ولكبر حجمها تتجمع هناك في ال vesselsوتسوي inflammatory reaction

***glomeruli**: is a common term used in anatomy to describe globular structures of entwined vessels, fibers, or neurons.

* https://www.youtube.com/watch?v=vNuijvjGZBE&index=4&list=LLhph2500OUDsKDIf2o-pH0A



MORPHOLOGY

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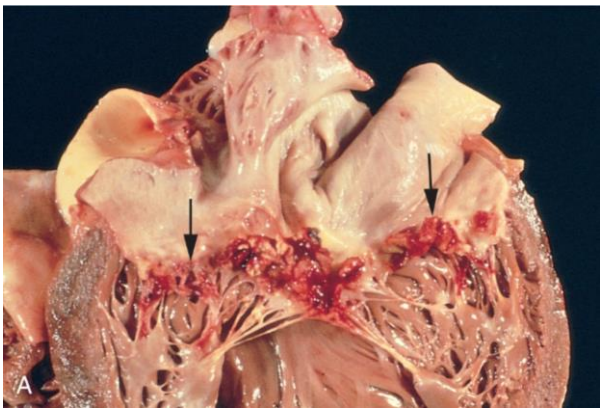
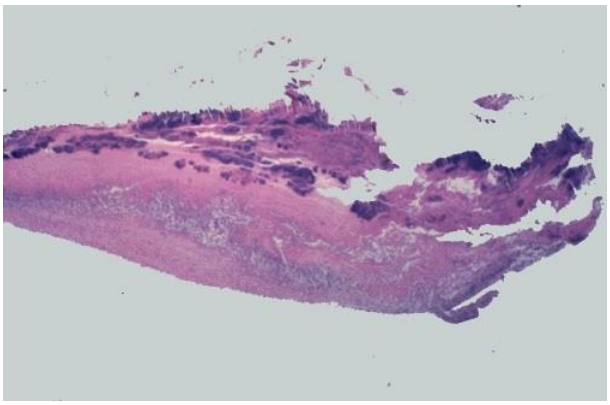
	
Proliferation ulceration & destruction of the cusps, wholes, vegetation, hemorrhage, dystrophic calcification[15].	**Microscopically, the valve in infective endocarditis demonstrates vriable vegetations of fibrin and platelets (pink) mixed with inflammatory cells and bacterial colonies (blue).**

Vegetation can be single or multiple and can involve more than one valve, the apparnce differ according to the causative agent.

Subacute endocarditis has less valvular destruction than **acute endocarditis**; the subacute vegetation has often granulation at their bases, promoting development of chronic inflammatory infiltrates, fibrosis and calcification over time.

When you look at infective endocarditis you will see very large vegetation and they usually very variable and they can be hemorrhagic and you see colonies of bacteria in it (وهنا المشكلة) because it variable and because it filled with bacteria they send septic emboli and they send it to variable areas in the body.

Other types of Endocaditis:

1. Non-Bacterial Thrombotic Endocarditis (NBTE)

Also called **Marantic endocarditis**, happens in weak people with diseases like (cancer, immunocompromised, advanced chronic diseases). It's Aseptic.

It is due to sterile vegetations[16] that arise in association with a **Hypercoagulable states**[17] or underlying adenocarcinoma. Vegetations arise on the mitral valve along lines of closure and result in mitral regurgitation. **(See pic A)**

-We have these **Verrucae** (كأنه ثالول) -------> Verrucous like growth on the valve cusps.

-Usually those patients who have (Non-Bacterial Thrombotic Endocarditis) we diagnose them **postmortem** (after death)

-So they are debilitated by their disease and they die, when we open the heart we will find the vegetation--> if we do culture it will be negative (does not have colonies of bacteria) so we call it Non-Bacterial Thrombotic Endocarditis or Marantic endocarditis

15 Is calcification of necrotic tissue associated with normal calcium level and caused by local inflammation.
16 small masses of fibrin ,platelets, and other blood components) on the leaflets of the cardiac valves
17 Hypercogulable states can be defined as a group of inherited or acquired conditions associated with a predisposition to venous thrombosis, arterial thrombosis, or both.

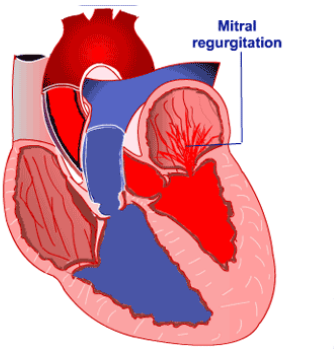
- Aortic valve most common site. The fibrin deposits are randomly arranged.
- May embolize to different parts of the body including brain, but the emboli are sterile.

Small thrombotic vegetations along the line of closure of the mitral valve leaflets (*arrows*)

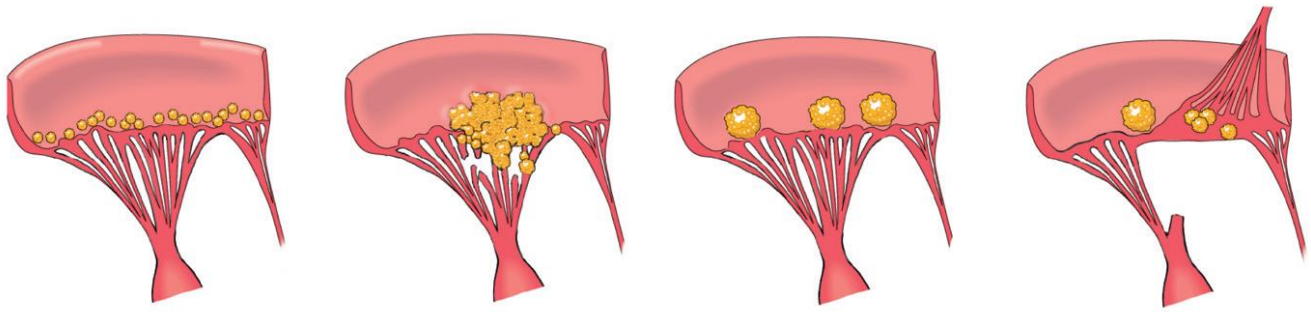
2. Libman-Sacks endocarditis

Characterized by the presence of sterile vegetations[18] on the valves of patients with **SLE**[19].

Less common, noninfective ,verrucous endocarditis associated with elevated levels of circulating immune complexes.



It happens to people who have **SLE** (autoimmune diseases); they are prone to develop Libman-sacks endocarditis in the advance stages. It is severe because it may cause fibrosis, cusps inflammation and other problems.



The major forms of vegetative endocarditis. The acute rheumatic fever phase of rheumatic heart disease is marked by the appearance of small, warty, inflammatory vegetations along the lines of valve closure; as the inflammation resolves, substantial scarring can result. Infective endocarditis (IE) is characterized by large, irregular, often destructive masses that can extend from valve leaflets onto adjacent structures (e.g., chordae or myocardium). Nonbacterial thrombotic endocarditis (NBTE) typically manifests with small to medium-sized, bland, nondestructive vegetations at the line of valve closure. Libman-Sacks endocarditis (LSE) is characterized by small to medium-sized inflammatory vegetations that can be attached on either side of valve leaflets; these heal with scarring.

[18] Abnormal growth
[19] Systemic lupus erythematosus الذئبة الحمراء

3. Carcinoid heart disease

Secretory products of carcinoid syndrome ,especially 5-hydroxytryptamine can cause endocarditis .The endocardial plaques are seen in the right side of heart

-Infects the valves especially **tricuspid** and it is endocarditis like.

- Carcinoid tumor differs from carcinoid syndrome even if there is a link between them.

- **Carcinoid tumor:** neuro endocrine cells which are abnormally proliferating and causing a tumor and these neuro endocrine cells because they have neuro secretary granules in them they secrete **vasoactive amines** (like serotonin)

- When we have (syndrome): these vasoactive amines are released to the circulation and they are causing symptoms because there effect on other organs

- Carcinoid syndrome: occur when the carcinoid tumor **metastasizes especially to the liver**, when it metastasizes to the liver it releases these **vasoactive amines** (serotonin, histamines and others)

If the patient has carcinoid syndrome he will have (diarrhea, flushing, abdominal pain and he may have what we called carcinoid related endocarditis, which usually effected **tricuspid valve.**

-Why the Tricuspid valve?

We think its Affect right side of heart because it activated in the lungs

VALVULAR HEART DISEASE:

Valvular disease results in:

1- **Stenosis** of valves: failure to open.

2- **Regurgitation** (or incompetence) of valves: insufficiency or failure to close. Result in (Backflow) of blood. Both cause murmurs.

- Stenosis or regurgitation can occur alone or together in the same valve.
- The outcome of valvular disease depends on the valve involved, the degree of impairment, the rate of its development, and the effectiveness of compensatory mechanisms.
- Valvular abnormalities can be congenital or acquired.

Causes:

- Most common cause of acquired valvular heart disease is post inflammatory scarring e.g. as a late result of rheumatic fever or secondary to various other inflammatory processes.
- Can occur even with prosthetic cardiac valves[20].
- Can be secondary to thrombus formation or infectious endocarditis.

[20] صمامات القلب الصناعية

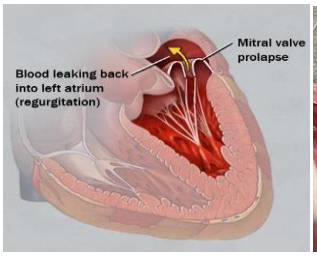
Myxomatous Mitral Valve *(Floppy [21] or prolapse mitral valve)*

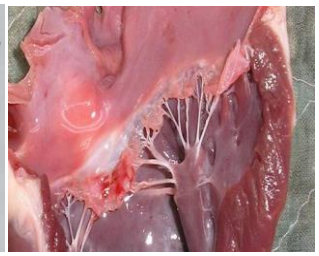
It's the most frequent valvular lesion in developed countries Seen in young women.

1) https://www.youtube.com/watch?v=nY4aaBezu9o&index=2&t=349s&list=LLhph2500OUDsKDIf2o-pH0A

2) https://www.youtube.com/watch?v=AHBzu5zhFuA

- There is myxoid / mucoid degeneration of the valve, which **causes ballooning of mitral valves (floppy cusp)**, results in stretching of the mitral valve, producing a **parachute deformity** of the cusp with prolapse of the cusp into the atrium during systole. These changes produce a characteristic **systolic murmur**.
- Pathogenesis unknown. can be a component of **Marfan syndrome***
- Most patient's asymptomatic but can result in mitral **insufficiency and arrhythmias**.
- Patients are **predisposed** to infective endocarditis.
- **No vegetation, no fibrosis.**





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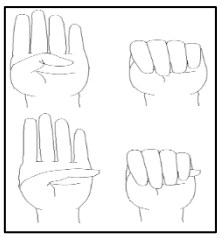


Mitral stenosis:

Stenosis is more common than regurgitation. Mitral stenosis is most commonly due to rheumatic heart disease.

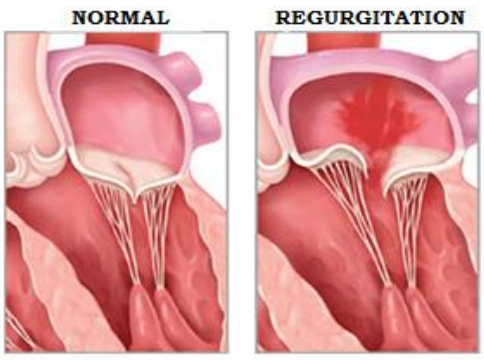
- In mitral stenosis (picture):

- Leaflets are thickened, fibrotic and fused leading to fish mouth/button hole deformity (stenosed valve looks like fish's mouth or button hole)
- Increased pressure, dilatation and hypertrophy of left atrium.
- secondary deposition of Ca++
- Pulmonary hypertension and lungs are firm and heavy (chronic passive congestion).
- Right heart may be affected later (right ventricular hypertrophy).

Mitral regurgitation:

It's usually a result of rheumatic heart disease. Can also result from mitral valve prolapse, infective endocarditis, or damage to a papillary muscle from myocardial infarction etc.

- Leads to left ventricular hypertrophy and dilatation.



[21] مرن أو مرتخي

***Marfan syndrome**: is a genetic disorder of the connective tissue.[2] The degree to which people are affected varies. **People with Marfan tend to be tall, and thin, with long arms, legs, fingers and toes**

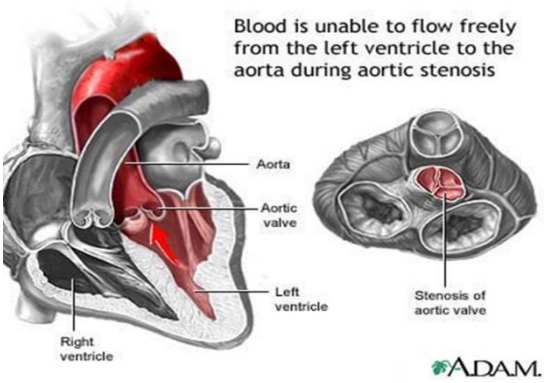
Aortic stenosis *(semilunar)**:***

Commonly caused by calcification and is called as calcific aortic stenosis. Calcific aortic stenosis can affect:

1. Normal aortic valve as part of the aging degenerative process seen in persons older than 60 years of age.

2. Congenital bicuspid aortic valve causing congenital aortic valvular disease.

3. Valve affected and scarred by rheumatic heart disease.



Aortic regurgitation/ insufficiency: ***Not that important***

Can be caused by:

1- Non-dissecting aortic aneurysm.

2- Rheumatic heart disease.

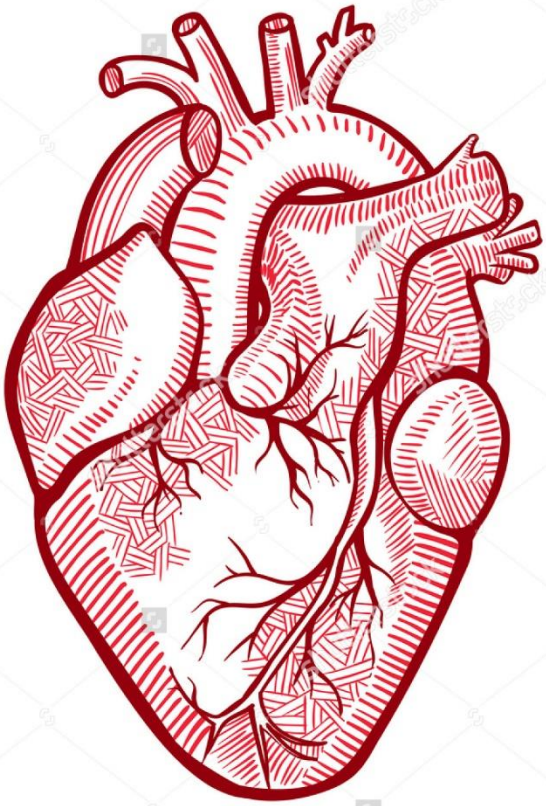
3- Infective endocarditis.

4- Syphilitic (luetic) aortitis (rare).

Right side of heart ***Not that important***

TRICUSPID VALVE: "I.V=S.aurse"
It is rarely involved in rheumatic heart disease along with the mitral and aortic valves.

PULMONARY VALVE:
- Seen in congenital malformations e.g. tetralogy of Fallot. Is very rarely involved in rheumatic heart disease



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