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PATHOPHYSIOLOGY AND CLASSIFICATION OF AORTIC DISSECTION

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Aortic dissection is an uncommon but potentially fatal disease with catastrophic complications. Its pathobiology is both complex and multifactorial, and is associated with several significant developmental risk factors. It is defined as the separation of the aortic media with presence of extraluminar blood within the layers of the aortic wall.

The walls of the aorta consist of three layers. The innermost layer is the tunica intima, which is formed by monolayer of endothelial cells, and is attached by a fairly loose connective-tissue sublayer to the middle layer called tunica media. This is a thick layer of about 50 layers of lamellar elastic fibers with interposed smooth-muscle cells and collagen fibers. The outermost layer is the tunica adventitia that includes collagen fibers, fibroblasts and vessels (vasa vasorum) supplying the aortic wall with oxygenated blood, while such thick vascular wall cannot rely solely on the diffusion of nutrients from the flowing blood in the lumen. Elastin fibers are highly stretchable, which permits the aorta to exhibit its distensibility and elasticity; contrary, collagen fibers are responsible for aortic integrity due to their relatively high stiffness. Integrity of the aortic wall is dependent on balanced remodeling of the extracellular matrix, predominantly of elastin, collagen and vascular smooth muscle cells (1).

Aortic dissection involves a longitudinal tear of the inner layer of the aortic wall, allowing blood to leak into the wall itself and cause separation of the layers within the aortic wall. As the tear extends along the wall of the aorta, blood can flow in between the layers of the blood vessel wall (dissection). Tears in the intimal layer result in the propagation of dissection (proximally or distally) secondary to blood entering the intima-media space. Entry of blood into intima-media space of thoracic aorta leads to a creation of a false lumen. False lumen may extend in an anterograde or retrograde direction and may occupy about 50 to 75% of aortal circumference. The vast majority of dissections originate in the sites with the greatest hydraulic stress, which are located within several centimeters above the sinuses of Valsava in the ascending aorta and just distal to the origin of the subclavian artery in the descending aorta. Location of dissection: ascending aorta 60%, descending aorta 30%, and aortic arch 10% (2).

In the pathophysiology of aortic dissection, hemodynamic factors and properties of the aortic wall play the most important role. Weakening of the aortic media and intimal disease are most probably related to a combination of inherited and acquired factors, which means

that aortic dissection is the end process of an array of different pathological processes causing weakening of the aortic wall (Tab. 1). These pathologies include (a) genetic disorders: Marfan's syndrome, Loeys-Dietz syndrome, Turner syndrome, the vascular form of Ehlers-Danlos syndrome, bicuspid aortic valve, familiar thoracic aneurism and dissection syndrome, (b) inflammatory conditions: Takayasu arteritis, giant cell arteritis and Behcet's disease, and (c) factors and/or pathological processes leading to an increase of aortic wall stress involve hypertension, trauma, aortalcoarctation, pheochromocytoma, cocaine use, smoking and weight lifting (3).

Tab. 1 Risk factors involved in pathogenesis of aortic dissection and their pathophysiological basis.

Risk factors	Pathophysiological basis
Genetic disorders Marfan's syndrome Loeys-Dietz syndrome Turner syndrome Ehlers-Danlos syndrome Bicuspid aortic valve Familiar thoracic aneurism and dissection syndrome	Weakening of the aortic media due to inherited disorders of extracellular matrix elements (e.g. fibrillin, type III collagen), mutations in receptors for transforming growth factor β, upregulation of matrix metalloproteinase, elastin deficiency and fragmentation
Inflammatory disorders Behcet's disease Giant cells arteritis Takayasu arteritis Syphilitic aortitis Bacterial or mycotic arteritis	T-cell mediated panarteritis affecting vasa vasora with inward extending or infiltration of the space around vasa vasora by lymphocytes, eosinophils, histiocytes and giant cells leading to aneurysm formation or fibrosis
Factors increasing aortic wall stress Hypertenzion Cocain use Aortal coarctation Trauma Weight lifting Smoking	High wall stress can cause medial degeneration.
Others Advanced age Dyslipidaemia Atherosclerosis Pregnancy	Diverse including aortic ulcer production

Genetic disorders underlying aortic dissection are known just partially. Deficiency of several genes including fibrillin 1, transforming growth factor β (TGFβ) receptors and type III procollagen has been identified as risk factors for development of aortic dissection. All of them cause extracellular matrix abnormalities, which result in diminution of integrity of elastic and muscular components of the media. Deficiency of fibrillin 1 is associated mainly with structural weakening of the aortal extracellular matrix and increased availability of TGFβ cytokines group. Elevated level of TGFβ causes increasing of

matrix metalloproteinases 2 and 9 activities, which leads to lysis of elastic fibers and break down the extracellular matrix. Additionally, mutations in receptor 1 and 2 for TGFβ have been detected in connective-tissue disorders associated with aortic dissection. Mutation in gene encoding collagen type III leads to affects in the incorporation of other microfibril components within the aortic media and interaction with vascular smooth muscle cells (3, 4).

CLASSIFICATION

Several different classifications have been advised to describe aortic dissection including clinical classification and anatomic classification. In addition, the European Society of Cardiology has come up with a more comprehensive etiological classification including also atypical forms of aortic dissection.

European Society of Cardiology Classification:
Class 1: classical aortic dissection with an intimal flap between true and false lumen
Class 2: medial disruption with formation of intramural haematoma/haemorrhage
Class 3: discrete/subtle dissection without haematoma, eccentric bulge at tear site
Class 4: plaque rupture leading to aortic ulceration, penetrating aortic atherosclerotic ulcer with surrounding haematoma, usually subadventitial
Class 5: iatrogenic and traumatic dissection

According to clinical classification aortic dissection is divided to acute and chronic. Acute dissection is diagnosed when the clinical symptoms have lasted 14 days or less. Beyond the 2nd week, the dissection is classified as chronic (5).

Anatomical classification includes two commonly used classification schemes: DeBakey classification, which categorizes dissections by the site of origin, and the Stanford classification categorizing dissections by involvement of the ascending aorta (Fig. 1). Acute Stanford type B dissection has been divided into four subgroups by Penn classification with further division based on the presence of risk factors for future aortic complications (6).

DeBakey Classification:
Type I: Beginning in ascending with involvement of arch aorta
Type II: Confined to ascending aorta only
Type III: Beginning in descending aorta

Stanford Classification:
Type A: Involvement of ascending aorta
Type B: No involvement of ascending aorta

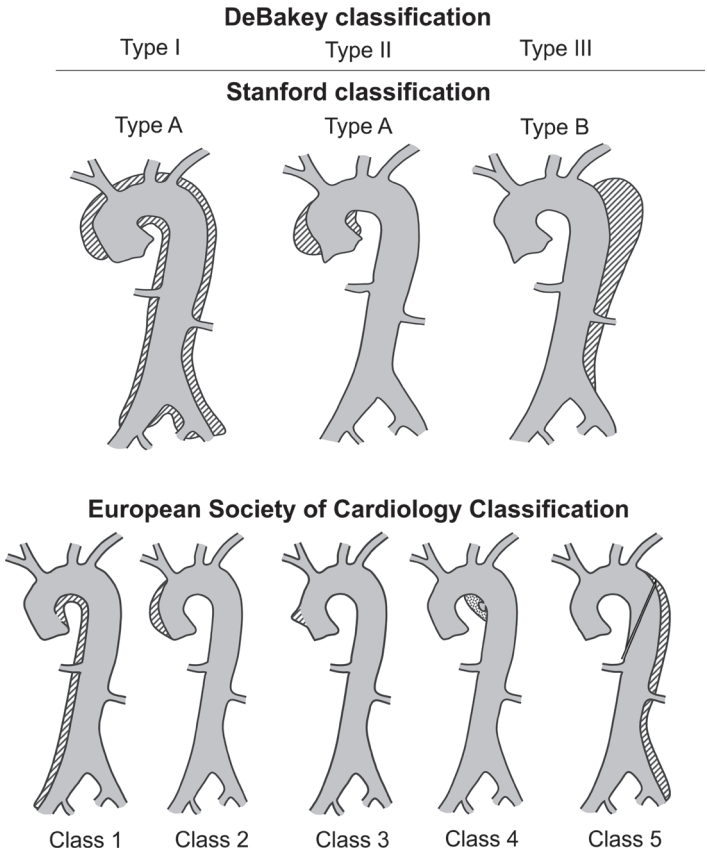

Fig. 1 Schematic image of aortic dissection's classifications.

CONCLUSION

The diagnosis of aortic dissection and the characterization of its type are crucial for appropriate treatment of patients. For clinical practice, it would be desirable to develop a clinical classification that would serve as a helpful guide to therapy (5). Partially Penn classification can serve to this purpose.

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SUMMARY

Aortic dissection is the most common catastrophic disorder to affect the aorta characterised by separation of the layers of the tunica media by ingress of blood, producing a false lumen. There are several factors involving in pathogenesis of this aortic disease including genetic, inflammatory, mechanical and other factors. This article summarise all available information about pathogenesis of aortic dissection and its classification.

Patofyziologie a klasifikace disekce aorty

SOUHRN

Disekce aorty je velmi závažný, život ohrožující stav, při kterém dochází k odtržení vnitřní vrstvy aortální stěny krevním proudem. Na vzniku disekce se podílí řada faktorů zahrnujících genetické, zánětlivé, mechanické a další příčiny. Tento článek přehledně shrnuje dosavadní poznatky o patofyziologii aortální disekce a dále obsahuje i její klasifikaci.

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